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FOR FIELD RECONNAISSANCE

Final Report

Principal Investigator
Roger W. McIntire, Ph.D.

September 1965

U. S. Army Contract No. DA-18-001-AMC-260(X)

Canine Behavior Laboratory
University of Maryland
College Park, Maryland

U. S. ARMY LIMITED WAR LABORATORY
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The advice and cooperation of the 26th Scout Dog Platoon, Fort Benning, Ga., was an essential contribution to the success of the contract. Their screening and selection of the last dogs to be trained is particularly appreciated.

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PART I. RESEARCH EXPLORING THE ALTERNATIVE MEANS OF DEVELOPING A FREE-RANGING RECONNAISSANCE SYSTEM.

A. Introduction to the problem.

The question investigated in the research reported here was the feasibility of training a free-ranging dog to perform personnel reconnaissance. The assumptions about terrain, weather and other pertinent conditions of the military problem were changed as the development of the project progressed. The general trend of these changes began with a consideration of a highly versatile canine reconnaissance system not dependent upon a particular handler, a pathway, or a particular kind of military unit to be protected. However, as the project progressed, the conditions for the operation of the system became more and more specified and limited. The final focus of the investigation was upon providing effective personnel reconnaissance for a foot patrol progressing along a pathway, trail, or road. The reconnaissance was to have adequate efficiency for providing warning of the presence of enemy personnel so that the patrol would be protected from an ambush consisting of small arms fire.

The scout dog program now maintained by the Army provides such reconnaissance, but was considered to have some disadvantages. In that present system the handler maintains the dog on leash and exposes himself in the same field position as the dog. If the patrol is following close behind and the wind bearing human scent is not favorable (see Fig. 1a), it is likely that the kill zone of the ambush will be entered before the dog alerts the handler. The advantages of the off-leash free-ranging dog are illustrated in Fig. 1b. In this case, the dog is preceeding the handler and the patrol at a

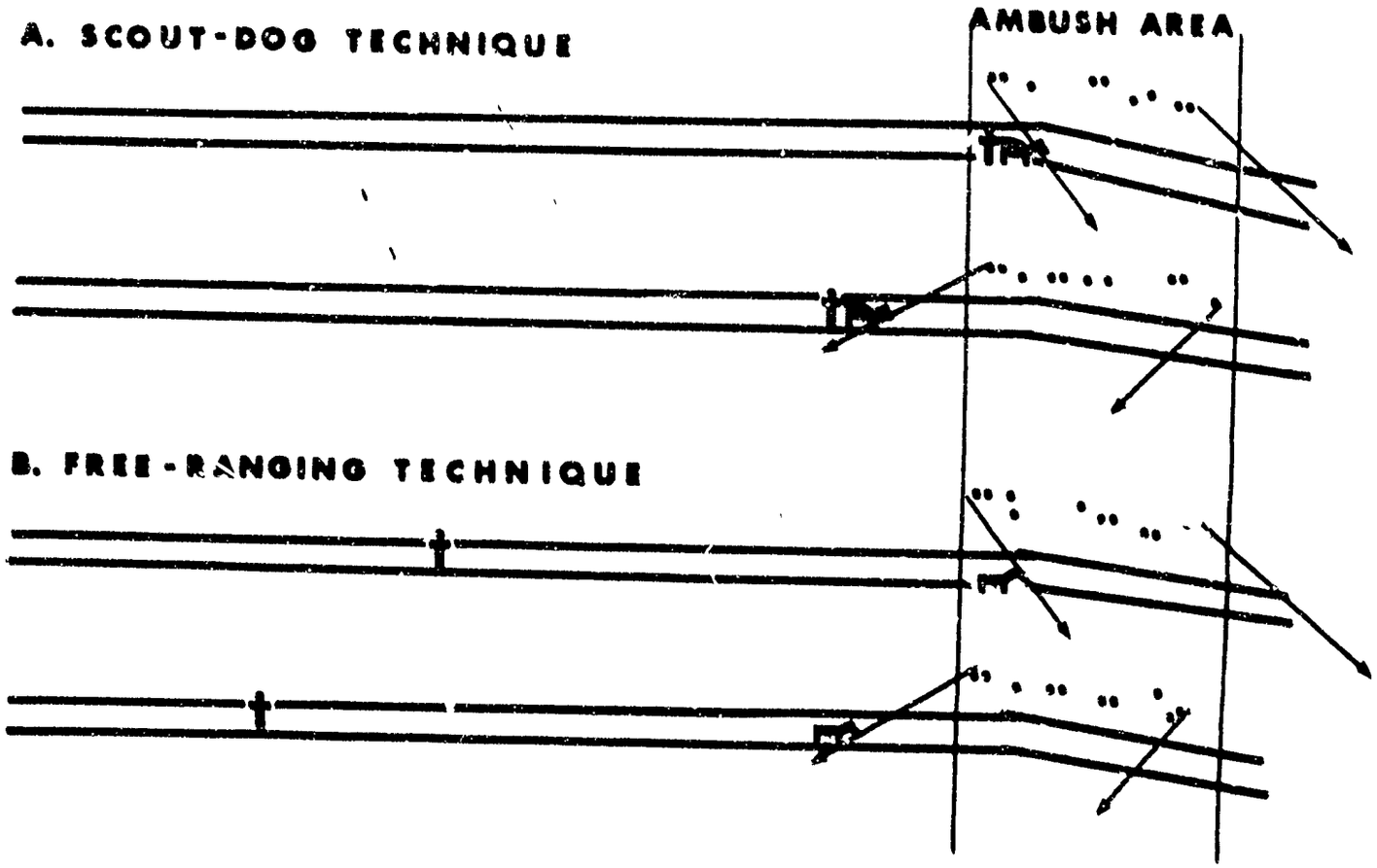

FIG. 1 THE MILITARY PROBLEM UNDER FAVOURABLE AND UNFAVOURABLE WIND CONDITIONS

distance and the likelihood of his giving an alert before the patrol or handler is endangered is greater. This increment in protection is, of course, magnified in the unfavorable wind conditions.

B. Investigation of the visual and olfactory capacities of the dog.

Although the excellent ability of the dog to use the air-borne scent of men as a means of alerting his handler is well known to the Army, his visual ability has been largely ignored. It was to investigate this ability that the following experiment was designed.

The purpose of this experiment was to define the characteristics of the limits of the dog's ability to discriminate between armed and unarmed men.

Subjects: Four subjects completed the experiment. They included two Beagle hounds, one Blue Tick Coon hound and one German Shepard. The animals were deprived of food for two days before the initiation of one-hour daily training sessions. Throughout the rest of the experiment the dogs' only source of food was the experimental apparatus.

Apparatus: The major apparatus consisted of a one-acre field enclosed on three sides with a seven foot wooden fence and on the fourth side by a windowless laboratory building. A four by seven foot experimental chamber

was placed in the center of this fourth side and airconditioned via ducts from the laboratory building. The side of the chamber facing the field was of thermopane glass which allowed a dog inside an unobstructed view of the field. Just inside the window were three panels bolted to the floor one foot apart. When one of these panels was pressed by the dog's paw, programming and recording equipment was activated inside the building. This equipment controlled a feeder which could provide 10 g. portions of a mixture of horse meat and Purina Dog Chow to a steel cup inside the experimental chamber.

Procedure: After the two days of deprivation mentioned above, each subject was given a one-hour session in the chamber each day. On Day 1 of this procedure only a lever press on any panel would bring about a food pellet. On Day 2 any two lever presses on the same panel would bring about a food pellet. From Day 3 forward, only one panel would bring about food pellets at any given time. Until a ratio of ten presses for one food pellet had been reached, the panel which would give food was changed randomly after each four rewards.

At this point the experimenter took control of which

panel would give pellets and would point to it from outside the window of the experimental chamber.

On the 20th day of the experimental procedure all subjects were choosing without hesitation the panel pointed to by the experimenter. For the next 20 days pointing by the experimenter was done with one of three instruments: 1) an M-1 rifle if the panel on the dog's left was to provide the food pellets, 2) a graden rake if the panel to the dog's right was to provide the food pellets, and 3) pointing with the hand if the middle panel was to give food pellets. From the 41st day forward, the appropriate instrument was held at "present arms" without pointing. If no instrument was to be used (middle panel) the experimenter merely stood in front of the window with his hands at his sides. From the 60th to the 90th day the distance of the experimenter from the window was varied from 5 to 100 feet under each of the following conditions: 1) experimenter prone, 2) experimenter standing, 3) experimenter crouching, 4) in daylight, 5) at dusk, and 6) at night.

Results and Conclusions: The three hounds used in the experiment responded at a better than chance level only in daylight with the experimenter standing and within 65 feet. The German Shepard, however, was consistantly

accurate at 100 feet in daylight when the experimenter was standing. However, under all other conditions responding was above chance only at the 5 and 10 foot distances with the night condition giving no occurrence above chance at all.

This experiment supports the conclusion that canine visual acuity as tested by a discrimination between a motionless armed or unarmed man is such as to be unreliable in a military situation.

C. Investigation of the bulb and harness technique.

In the interim report submitted on July 12, 1964 (Appendix A) development of a system for personnel reconnaissance was described which used food as a reward for the dog's successful performance of pulling a bulb on his harness when he had contacted a man in his search. This bulb was attached to a switch which activated a radio signal monitored by the handler. The handler then transmitted a signal to the dog recalling him to receive the reward.

On 13 July, 1964 the present author assumed the responsibility of Principal Investigator to perform the experiment in vision described above, and to continue development and training of the reconnaissance system described above with few modifications. During this time, and during the discussion involved in a demonstration of the system held at Aberdeen Proving Ground in October of that year, several character-

istics of the system were noted.

First, the bulb pulling response was a strange and unique response for the dog to make. This meant that only a quite obvious and blunt stimulus could bring it about. Therefore, the dog had to make a visual contact with the decoy before he would respond by pulling the bulb. Training this response was equally difficult and was not a procedure similar to any used by the Scout Dog Platoon which was visited at about this time by personnel associated with the contract.

Second, the dogs were not well disciplined and tended to run and search at will rather than under the close direction of training or direction from the handler.

Third, the use of food reward and the necessity of a pack on the dog to send and receive tones, plus the pack necessary for the handler to send and receive tones, became a great load of equipment and meterial. It was difficult to see how this much of a logistical problem would be justified in an operational system. Also, the dog eventually satiates and quits working, and, of course, since the dog must be kept hungry he is more vulnerable to illness.

On 13 December, 1964 a new program was begun to deal with these deficiencies.

PART II. DEVELOPMENT AND MODIFICATION OF THE PROPOSED SYSTEM.

A. Examination and development of a new alert indicator.

As indicated in Part 1, the previous attempts to develop a canine free-ranging reconnaissance system found great difficulty in training the dog to make a response which would operate a radio. Once this was accomplished selectively rewarding the dog would develop the situation where the dog would perform only in the presence of a man. All manners of closing switches seem to be extremely strange behaviors to a dog and difficult to train.

In the first stages of research (see above) many systems had been tried and bulb pulling was the most successful. Even with this system the response could not be trained to occur on the mere scent of a man, but only on close visual contact.

At this point it was brought to the investigator's attention that a commercial device was available which consisted of a collar holding a transmitter which varied its output of a tone as a result of motion. This device was used to indicate to a hunter when his dog was "on a point". This was, in effect, a response which operated a radio, and, in addition, it was a response which seemed amenable to being brought under the control of a subtle stimulus such as the air-borne scent of a man.

However, the commercial version had several disadvantages when considered as an alert indicator for the reconnaissance system. For example, low power output (10 milliwatts) prevented effective long range communication. Secondly, the use of a u.h.f. channel

(450 Mhz) provides poor penetration of foliage*. In fact, jungle path losses at these frequencies are sufficient to rule out the use of u.h.f. for all jungle purposes exceeding a few hundred feet. Thirdly, the transmitter frequency and type of modulation were not compatible with any existing Army communication apparatus.

Also, the "Setter Seeker" has incorporated in the transmitter housing a propriatory device which is called a "jiggle switch". It is an on-off device which switches as the dog bounces during normal motion. Thus, only motion or non-motion could be interpreted and discrimination between walking, running and heavy panting was impossible. Because of these disadvantages the contract allowed that a similar device, with the modifications indicated by these problems would be constructed by the laboratory. In the constructed device (see Fig. 2, also Appendix D) the contractors have developed a replacement for the "jiggle switch" which will hereafter be referred to as a motion transducer. It is basically a resistance accelerometer. As the dog jostles in walking, the motion transducer produces a unique change in resistance proportional to the instantaneous acceleration of the motion transducer. The advantage of this <u>proportional</u> output over the switching type of system is an increase in the ability of the handler to assess a more exact characterization of the behavior of the dog. With proportional output, the practiced handler can dis-

*See: Final report for parametric study of pulsed radio frequency transmission. Task # 1. Contract # DA-19-001-AMC-314(X).

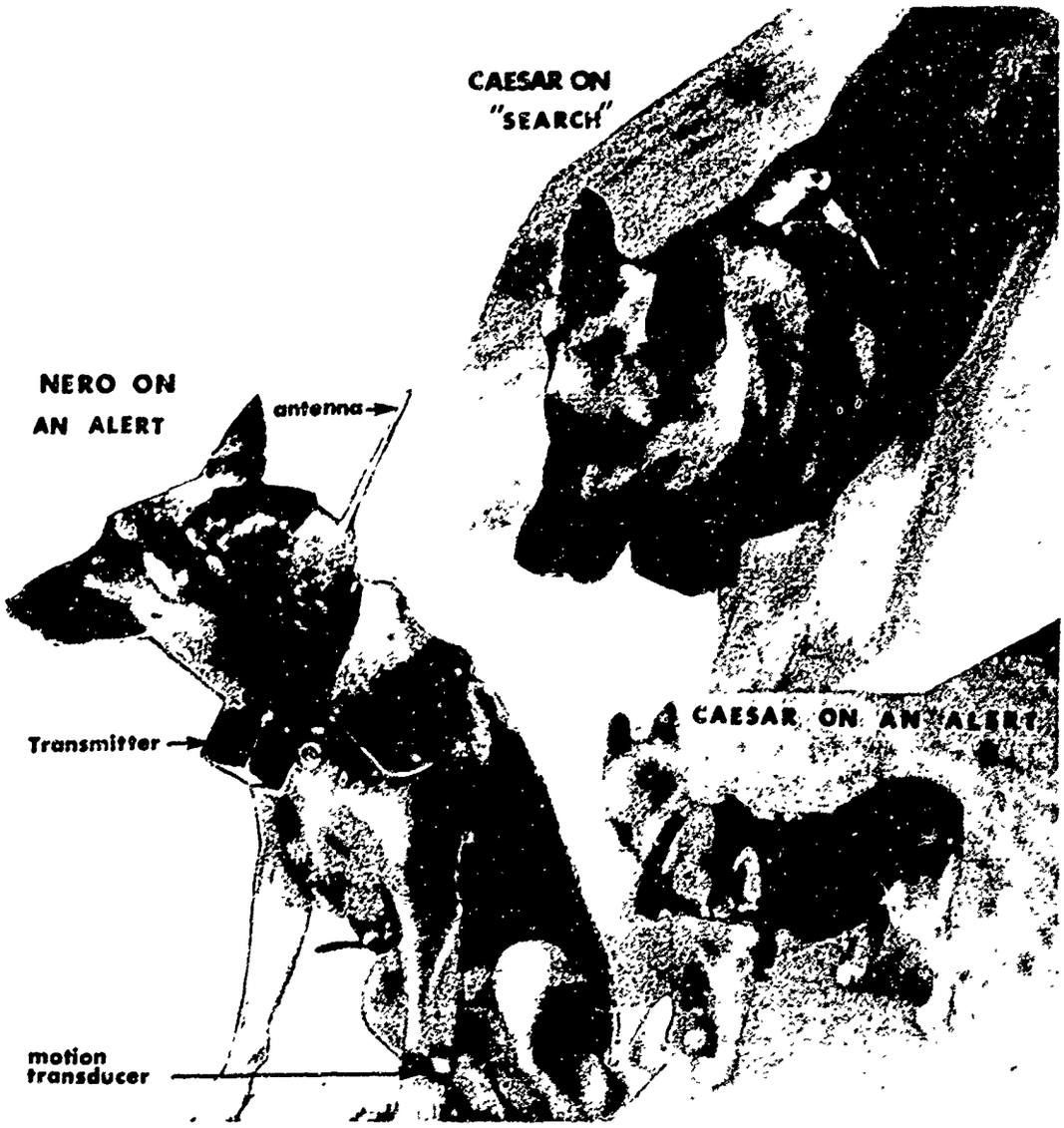

FIG. 2 POSITION AND USE OF THE SPECIAL EQUIPMENT

criminate between running and walking and can assess the vigor with which the dog is performing his task. Operationally, the resistance of the motion transducer is converted to an audio tone and the audio tone is telemetered from the dog via an F.M. transmitter to the receiver carried by the handler. The changing audio tones are then interpreted by the handler as an indication of the behavior of the dog. The basic housing of the motion transducer is the glass bulb and electrodes of a neon lamp (NE-83). The seal is broken, and instead of neon gas, the bulb is partially filled with carbon granules, such as are used in carbon microphones*. The bulb is then resealed and the entire assembly is encapsulated in epoxy.

The dog radio pack was designed to be compatible with the RT-176/PRC-10 radio transmitter-receiver.

This restricted the design of the dog transmitter to narrow band F.M. in the frequency range of 38 to 55 Mhz. An added advantage of this choice of receiving equipment is that with the use of the directional antenna AT-399/PRC, the location of the dog may be tracked while the animal is out of sight of the handler.

The transmitter is housed in a waterproof aluminum container approximately 2.5"x3"x4". The case is mounted to the bottom of a leather dog collar, and the antenna is mounted on the top of the collar. The weight of the transmitter keeps the antenna upright, and

*Source of supply: Granular carbon, size 80, grade Lmx.
National Carbon Co., Inc., Cleveland, Ohio.
Division of Union Carbide and Carbon Corp.

the range of transmission is approximately 300 yards under dense foliage conditions, better in less obstructed terrain.

The motion transducer was initially mounted in the transmitter housing. The transmitter housing, transducer, collar, and antenna formed an integral package. It was found, however, that if the motion transducer were strapped directly on the foreleg of the dog, much in the fashion of a wristwatch, the signal received by the handler was much easier to interpret. This type of mounting is less desirable mechanically, since a cable must be used to connect the motion transducer to the transmitter housing. The cable, and the motion transducer are subject to snagging in underbrush and may be either damaged or lost. The increase in maintenance caused by the exterior placement of the transducer is counter-balanced by an increase in signal readability.

B. The substitution of praise for food reward.

As mentioned at the conclusion of Part 1 of this report, the use of food reward has many procedural and logistical problems associated with it. In addition to these experiences, close advise and consultation from the 26th Scout Dog Platoon at Fort Benning, Georgia, convinced the personnel directly associated with the program that praise from the handler as described in FM 20-20 (Military Dog Training and Employment) should be used instead of food reward. This change in training procedure allowed several advantages:

1) The dog need not be kept hungry and vulnerable to ill health.

2) No special equipment is necessary to reward the dog during field exercises.

3) Satiation is no longer a problem.

C. Selection of subjects.

In the preliminary investigations of the problems several canine breeds were used (see Appexdix A). Most promising of these were the Labrador Retrievers and the German Shepards. For the development of the final system the German Shepard was selected for the following reasons:

1) The Shepard showed potential in the preliminary work.

2) Dogs found acceptable by the Army were to be used; their experienced judgment was with German Shepards.

3) The future possibility of integrating the system with the training procedures of the Army Scout Dog (all Shepards) was a consideration.

D. Preliminary training.

Although a complete detailed description of the train procedures is incorporated in the training manual (Appendix B), it is necessary to review these procedures before presentation of the results of field tests in Part III.

Following the procedures outlined in FM 20-20 a single handler

was assigned to a single dog as the animals arrived at the laboratory. After 6 January, 1965 only dogs approved at Fort Benning in the procedures used there to select dogs for scout dog training with the 26th Scout Dog Platoon were used. On that date four dogs were received and two of them were placed in obedience training immediately.

Some commands such as "STAY" and "COME" were emphasized because of their need in the future off-leash work. Scout dog training was also begun in the first few weeks and was also in accordance with FM 20-20. In these procedures the dog is worked on a short leash (6 foot) attached to a body harness. He is allowed to explore the trail ahead of the handler with his head up sampling the air. The command given at the outset of the problem is "SEARCH". A characteristic behavior is noted when the dog contacts the odor of a man. This alert-behavior varies with individual dogs but is usually a pulling on the leash with a perking up of the ears and hackles.

As the handler showed an awareness of his dog's characteristic alert, the longer (25 foot) scout dog leash was used to replace the 6 foot leash. When the handler detected the alert of the dog, the command "STAY" would be given and the leash slackened. After a brief interval (usually 30 sec.) the dog was returned to the handler by a whistle which at first needed to be given alternately with "COME", but later was a sufficient command in itself.

Off-leash field problems began subtely by the mere dropping of the leash by the handler. The dog was allowed to proceed dragging the leash and to alert on the decoy. At this point, the handler gave

the command "STAY" if the dog had not spontaneously stopped. If the dog had stopped, the handler merely waited 30 sec. and returned the dog by the whistle and praised him. On increasingly frequent occasions the 25 foot leash was not attached to the harness stall before the search problem began.

Thus, the daily training exercises began with the removal of the choke collar used for discipline and the attachment of the body harness. When the dog was expected to move out to a distance which might keep the handler from seeing the typical stop-alert, the motion transducer described above was also put on the dog. The dog moved out on the command "SEARCH" and maintained a trail distance of about 200 yards ahead of the handler.

PART III. RESULTS OF TRAINING EXERCISES.

A. Daily training exercises.

When the dogs received from the 26th Scout Dog Platoon were begun in field trials, a session summary sheet was constructed to collect all the information which was believed to be of value. Such a summary sheet is presented in Table 1. The headed columns bear some explanation.

Column 1 - Date, time in/cut.

All animals receive an hour and a half training each morning and each afternoon. Some variance is encountered due to weather, etc., so a separate record is needed.

Column 2 - Cum. Tot. Time.

Cummulative total time spent with the animal in training is, so far, our best predictor of the animal's level of performance.

Column 3 - Discipl. Time.

Discipline time is spent with an emphasis on commands given at a distance (stay, come, go, sit, etc.). Until 60 hours is logged in discipline time, no trail work is attempted.

Column 4 - Worst Command.

This allows the Responsible Investigator an estimate of the dog's performance level at a glance.

Column 5 - No. of Trials.

Columns 5 through 19 refer to trail work. In this case, "trials" mean number of reconnaissance problems set up.

Column 6 - No. Persons w/Hand.

The number of people moving with the handler is recorded here.

Column 7 - No. of Decoys.

The number of persons concealed in ambush for each problem is recorded here.

Column 8 - Who?

This information allows the Responsible Investigator to insure that the dogs do not become dependent on one or a few decoys.

Column 9 - Setter Seeker.

The use or non-use of radio equipment on the dog is recorded here.

Column 10 - Weather.

Column 11 - $\overline{M}$ Initial Dist. to Decoy.

Mean initial distance to the decoy refers to the distance from the handler to the decoy when the dog is sent out.

Column 12 - $\overline{M}$ Final Dist. to Decoy.

Mean final distance to decoy shows how much warning the handler has received due to the system.

Column 13 - 1-5 Concealment.

Degree of concealment is rated here (1= standing at the side of the trail, 5= completely concealed in full effort to remain undetected).

Column 14 - $\bar{M}$ Dist. Dog - Decoy.

The distance between the decoy and the dog at the time of detection is recorded here.

Column 15 - Rate Come Back 1-5=Bad.

The latency with which the animal returns on command is rated here (1=upon one short blast of the whistle the dog came straight back on a dead run, 5= the dog had to be called verbally).

Column 16 - Rate "Fooling" 1-5=Bad.

The general enthusiasm of the dog for the problem is rated here (1=continued to work steadily needed no verbal commands, 5=dog continuously goofed off, needed continual verbal discipline).

Column 17 - Stay Command.

At the first stages of trail work, the stay command is given verbally by the handler when the decoy radios that they have been detected. The gradual deletion of this command is recorded here.

Column 18 - % of Time on Smell.

The dependence of the dog on olfactory cues is estimated here.

Column 19 - % of Time on Vision.

The dependence of the dog on visual cues is estimated here.

Columns 1-5 were used merely to indicate the progress that was being made with an individual dog in regard to discipline, and time spent in training. Columns 6-11 defined the nature of the field reconnaissance problems being presented and Columns 12-19 characterized the dog's performance.

Summarized in Tables 2 and 3 are the data collected from daily training exercises of Caesar and Nero. These tables present mean values for successive blocks of five problems.

For Nero, the average of Column 12 (final distance from handler to decoy) was 155 yards over May and June, while the average for Column 14 (final distance from dog to decoy) is 49.3 yards. It is this 106 yards difference that is the advantage of the free-ranging reconnaissance dog over the regular scout dog. Other important factors in this table are that temperature and number of persons composing the decoy are not factors. For example, under "warm" conditions (80-85°) Nero averaged 42 yards distance to decoy and under "hot" conditions (above 85°) he averaged 55 yards distance. If anything, he was doing better in the hot weather. However, his general enthusiasm was much worse which subtracts confidence from those using him in hot weather.

TABLE 2

NERO'S PERFORMANCE IN TWO MONTHS TRAINING

DOG - NERO

Date	No. persons w/hand.	No. of Decoys	Weather	M initial dist. to decoy (yards)	M final dist. to decoy (yards)	1 - 5 Concealment	M final dist. dog-decoy (yards)	% Time on Smell
1	6	7	10	11	12	13	14	18
April 1	0	1	Cool	150	50	3	6	100
April 2	0	1	Cool	200	75	3	13	100
April 5	0	1	Cool	160	25	4	12	100
April 7	0	1	Cool	350	75	4	6	100
April 8	0	1	Cool	230	16	4	8	100
April 9	0	1	Cool	1000	75	4	50	100
April 12	0	1	Cool	800	70	3	50	100
April 13	0	1	Cool	150	6	3	3	100
April 13	0	1	Cool	189	18	3	7	100
April 16	0	1	Cool	750	75	4	50	100
April 18 - 20	0	1	Cool	605	62	4	27	100
April 21	0	1	Cool	750	80	4	40	100
April 23	0	1	Warm	800	70	4	30	100
April 20 - 26	0	1	Warm	680	66	4	25	100
April 27	1	2	Warm	500	75	4	30	100
April 28 - 29	2	2	Warm	830	85	4	25	100

TABLE 2 - CONTINUED

DOG - NERO

Date	No. persons w/hand.	No. of decoys	Weather	$\bar{M}$ initial dist. to decoy (yards)	$\bar{M}$ final dist. to decoy (yards)	1-5 Concealment	$\bar{M}$ dist. dog-decoy (yards)	% Time on smell
1	6	7	10	11	12	13	14	18
April 30 - May 3	1	1	Warm	680	77	4	27	100
May 3 - 4	2	2	Warm	330	75	5	25	100
May 4	0	1	Hot	152	69	4	36	100
May 5	1	1	Hot	810	134	4	53	100
May 6	0	1	Warm	540	94	4	50	100
May 7 - 10	0	1	Rain	311	94	4	61	100
May 10 - 11	0	1	Hot	570	99	5	62	100
May 11 - 12	0	1	Warm	300	109	4	47	100
May 12 - 13	2	1	Warm	360	77	4	38	100
May 17	0	1	Warm	810	120	5	68	100
May 18 - 19	0	1	Warm	340	77	4	52	100
May 19 - 20	0	1	Warm	310	70	5	37	100

TABLE 2 - CONTINUED

DOG - NERO

Date	No. of persons w/hand.	No. of decoys	Weather	$\bar{M}$ initial dist. to decoy (yards)	$\bar{M}$ final dist. to decoy (yards)	1-5 Concealment	$\bar{M}$ dist. dog-decoy (yards)	% Time on smell
1	6	7	10	11	12	13	14	18
May 20 - 21	0	1	Warm	175	79	4	50	100
May 21 - 24	0	1	Warm	215	86	4	41	100
May 24	0	1	Hot	250	130	4	60	100
May 25 - 28	0	1	Warm	910	85	5	60	100
May 28	0	1	Warm	280	85	4	43	100
May 31	0	1	Warm	260	118	5	84	100
May 31 - June 1	0	1	Hot	620	580	4	90	100
June 1 - 2	0	1	Hot	880	700	5	70	100
June 2 - 3	1	1	Rain	630	363	5	50	100
June 4 - 9	0	1	Warm	591	560	5	72	100
June 9 - 10	1	1	Hot Damp	249	129	5	29	100
June 10 - 11	0	1	Hot Damp	136	102	5	29	100

TABLE 2 - CONTINUED

DOG - NERO

Date	No. persons w/hand.	No. of decoys	Weather	$\bar{M}$ initial dist. to decoy (yards)	$\bar{M}$ final dist. to decoy (yards)	1-5 concealment	$\bar{M}$ dist. dog-decoy (yards)	% Time on smell
1	6	7	10	11	12	13	14	18
June 11 - 14	0	1	Hot	310	82	4	42	100
June 14 - 15	1	2	Warm	450	119	4	43	100
June 17	0	1	Rain	205	90	4	49	100
June 17 - 20	0	1	Warm	325	77	4	18	100
June 20 - 21	0	1	Warm	227	66	5	37	100
June 21 - 22	0	1	Warm	390	93	4	73	100
June 22 - 24	8	10	Hot	500	116	5	47	100

Number of persons composing the decoy (Column 7) was varied between 1, 2, 3, 4, and (seldom) 10. The trail block averages come out to 1, 2 and 10. This does not seem to be a significant factor. In about 10% of the problems the dog passes the decoy entirely and gives no alert. These situations are usually where a wind bearing is from the dog to the decoy. In May and June, Nero made 32 such errors. Caesar made 21.

In the later work, length of problem (Column 11) and degree of concealment (Column 13) were not significant factors in predicting success. Since by the judgement of the handler the animal seems to work totally on smell (Column 18) visual concealment doesn't mean anything.

For Caesar (Table 3), the mean final distance to the decoy is 150.2 yards for May and June while the mean distance from the dog to the decoy at the time of the alert is 70.0 yards. Again, this 80 extra yards of safety for the handler is the crucial difference between the free-ranging and scout dog reconnaissance systems. Caesar was worked on a leash extensively in early training and occasionally later on. These 30 problems with the leash in May (see Table 3) contribute to lowering the margin of safety expressed above as 80 yards. On these trials Caesar provides only the protection of a scout dog. Two general conclusions are indicated by these tests.

1) The system may be worked with or without a leash.

2) The dog-decoy distance is not effected by the leash factor.

TABLE 3

CAESAR'S PERFORMANCE IN TWO MONTHS TRAINING

DOG - CAESAR

Date	No. persons w/hand.	No. of decoys	Weather	$\bar{M}$ initial dist. to decoy (yards)	$\bar{M}$ final dist. to decoy (yards)	1-5 Concealment	$\bar{M}$ dist. dog-decoy (yards)	% time on smell
1	6	7	10	11	12	13	14	18
April 2 - 4	2	2	Cool	300	110	2	(leash) 110	100
April 4 - 5	1	1	Cool	300	110	4	(leash) 110	100
April 5 - 7	0	1	Cool	600	45	3	(leash) 45	100
April 7 - 9	0	1	Cool	630	75	2	(leash) 75	100
April 9 - 10	2	2	Cool	480	96	2	(leash) 96	100
April 10 - 13	1	2	Cool	300	60	2	(leash) 60	100
April 13 - 15	0	1	Cool	450	110	5	(leash) 110	100
April 15 - 19	1	1	Cool	600	120	4	(leash) 120	100
April 19 - 20	0	1	Cool	315	180	3	(leash) 180	100
April 20 - 23	1	1	Warm	225	150	3	(leash) 150	100

TABLE 3 - CONTINUED

DOG - C'ESAR

Date	No. persons w/hand.	No. of decoys	Weather	$\bar{M}$ initial dist. to decoy (yards)	$\bar{M}$ final dist. to decoy (yards)	1-5 Concealment	$\bar{M}$ dist. dog-decoy (yards)	% Time on smell
1	6	7	10	11	12	13	14	18
April 23 - 25	1	2	Warm	300	56	2	(leash) 56	100
April 25 - 26	1	1	Warm	360	150	3	(leash) 150	100
April 26 - 27	1	1	Warm	180	45	3	(leash) 45	100
April 27 - 29	1	1	Cool	360	60	3	(leash) 60	100
April 29 - 30	1	1	Warm	460	30	2	(leash) 30	100
April 30 - May 3	1	2	Warm	310	168	4	30	100
May 4 - 5	1	2	Hot	200	57	5	47	100
May 5 - 6	0	2	Hot	240	81	4	60	100
May 6 - 10	0	2	Rain	160	40	4	(leash) 40	100
May 10 - 13	1	1	Cool	210	122	5	62	100

TABLE 3 - CONTINUED

DOG - CAESAR

Date	No. persons w/hand.	No. of decoys	Weather	$\bar{M}$ initial dist. to decoy (yards)	$\bar{M}$ final dist. to decoy (yards)	1-5 Concealment	$\hat{M}$ dist. dog-decoy (yards)	% Time on smell
1	6	7	10	11	12	13	14	18
May 13 - 14	2	1	Cool	340	165	5	(leash) 165	100
May 14 - 17	0	1	Cool	320	69	5	(leash) 69	100
May 17 - 18	0	1	Cool	588	174	5	72	100
May 18 - 20	0	1	Warm	600	150	5	(leash) 150	100
May 21 - 23	0	1	Cool	660	32	5	(leash) 32	100
May 24 - 25	0	1	Hot	660	66	5	(leash) 66	100
May 25 - 26	0	1	Hot	630	69	4	42	100
May 27 - 28	0	1	Hot	825	180	5	123	100
May 28 - 31	0	1	Hot	690	186	4	110	100
May 31 - June 1	0	1	Cool	630	144	4	90	100

TABLE 3 - CONTINUED

DOG - CAESAR

Date	No. persons w/hand.	No. of decoys	Weather	$\overline{M}$ initial dist. to decoy (yards)	$\overline{M}$ final dist. to decoy (yards)	I-5 Concealment	$\overline{M}$ dist. dog-decoy (yards)	% Time on smell
1	6	7	10	11	12	13	14	18
June 1 - 4	0	1	Cool	555	63	5	36	100
June 4	0	1	Cool	810	342	4	84	100
June 7	1	1	Cool	510	186	5	153	100
June 9	0	1	Hot	690	156	5	54	100
June 10	0	1	Warm	540	138	4	42	100
June 10 - 11	0	1	Warm	870	510	4	54	100
June 11 - 14	0	1	Warm	390	165	5	60	100
June 14 - 15	0	2	Warm	660	225	3	60	100
June 15	2	1	Cool	630	156	5	66	100
June 16	0	1	Cool	555	159	5	72	100
June 17	1	1	Rain	660	138	4	30	100
June 18	1	1	Cool	875	174	4	60	100
June 21	0	2	Hot	390	72	5	24	100

TABLE 3 - CONTINUED

DOG - CAESAR

Date	No. persons w/hand.	No. of Decoys	Weather	$\overline{M}$ initial dist. to decoy (yards)	$\overline{M}$ final dist. to decoy (yards)	I-5 Concealment	$\overline{M}$ dist. dog-decoy (yards)	% Time on smell
1	6	7	10	11	12	13	14	18
June 21	0	2	Hot	600	186	4	66	100
June 22	0	1	Hot	1000	150	4	45	100

B. Exercise for an invited audience.

On June 23 and 24, 1965 a demonstration was presented for observation and evaluation by officials of the Limited War Laboratory, Aberdeen Proving Ground, Maryland, and other invited guests.

The two German Shepards (Caesar and Ne), each twenty four months old, were the dogs used. Both had undergone approximately five months of training under the direction of the Canine Behavior Laboratory. The training had advanced the dogs through stages of traditional on-leash scouting to intermittent periods of in-range off-leash scouting (allowing for close verbal control), to the ultimate stages of independent isolated reconnaissance.

In order to reliably assess the overall potential of the program in field use, an area at Fort Meade, Maryland, was used and approximated as realistically as possible the conditions to which the dog might be subjected if in operational use. The conditions included well defined roadways, open field areas, and obscure pathways and trails leading through dense underbrush in heavily forested areas.

Attending personnel were divided into the ambush and patrol. To further facilitate an evaluation, observers occasionally joined the ambush party. Members of the patrol included the predesignated patrol leader, the handler and observers. The patrol leader determined the route the patrol followed and the ambush was set up at a point along that route unknown to the handler or the rest of the patrol. In most situations the ambush was situated along side the route ten to thirty yards from the trail spread out along twenty to ninety yards of the

route. The handler informed the patrol leader when the dog had given an alert. This information was used for identifying the general area of the ambush, and then the actual position of the ambush was noted. In evaluating the validity of the alert given by the dog, all relative information was compiled and assessed. Most important of these factors was the direction of the wind and the velocity of the wind measured in knots. Other data considered were the temperature, humidity, distance from dog to ambush, density of vegetation, etc.

Each trial was prearranged to exploit the performance of the dog under many diverse situations such as path junctions, inaminate objects (motor vehicles, etc.), routes with almost no identifiable course, and open fields.

Problems with the above situations are illustrated in Fig. 3. Some explanation of the significance of each of these problems is necessary:

1. Path junctions occurred along the routes in problems 4-6, Nero, and 2, 4, 5, Caesar.

2. In an attempt to test whether or not certain objects along the route would elicit a response from the dog, two problems were arranged with the following conditions: near the end of Problem 1 of Nero's performance, ruins of an old house were present but produced no alert; also, on Problem 4 of Caesar's performance an Army vehicle situated to the right of the route elicited no alert.

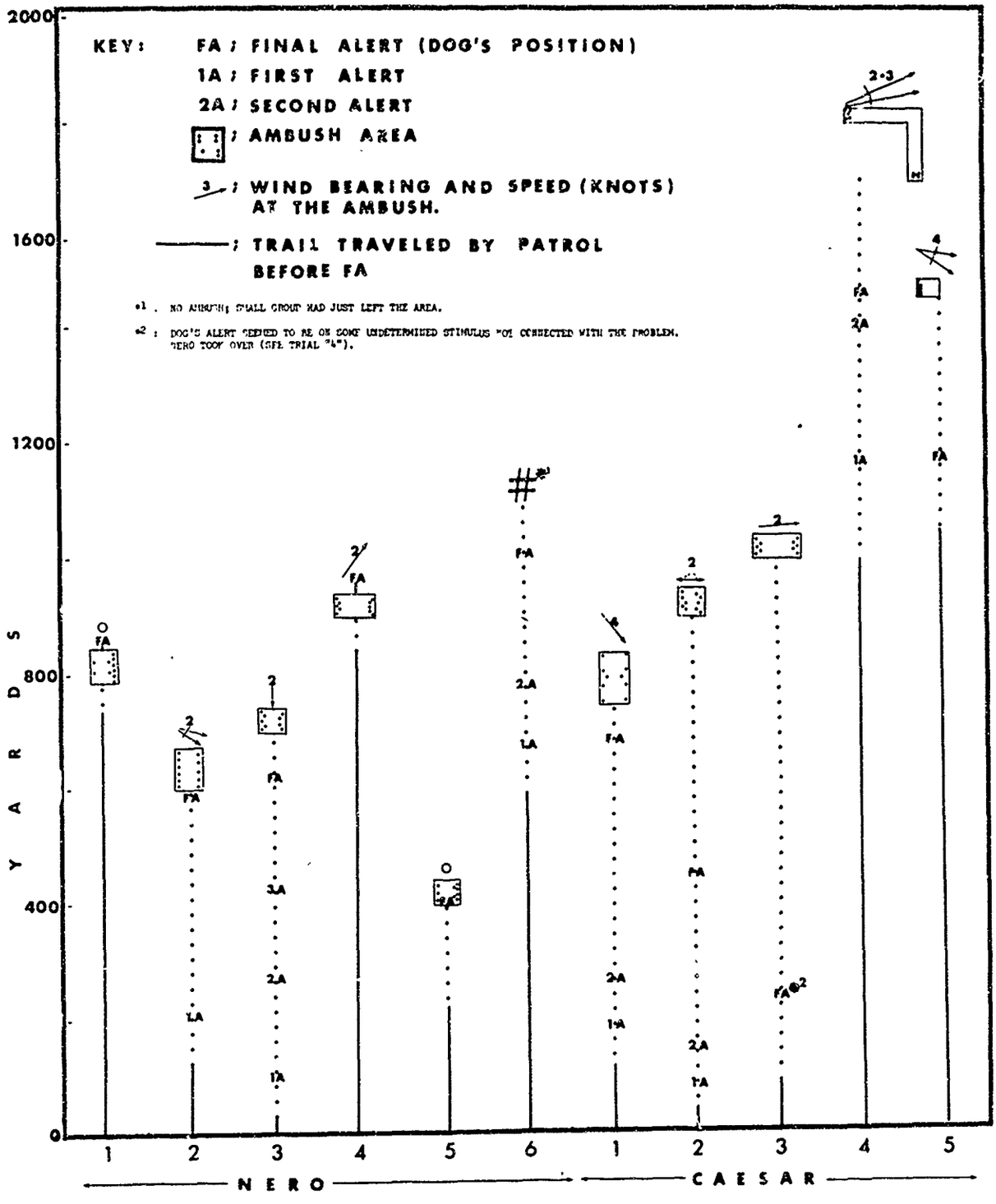

FIG. 3 ILLUSTRATION OF THE PROBLEMS IN THE TWO-DAY EXERCISE

3. In order to determine the necessity of having a natural pathway for the dog to follow, Problem 6 - Nero, and 5 - Caesar, began with a clearly defined path which, after approximately 400 yards, grew less discernable due to a large overgrowth of foliage. Both dogs continued along the intended route with no indicated confusion.

4. Problem 4, Caesar, the illustration indicates a problem routed across an open field with the ambush party separated into two units. A first alert was given midway across the field.

5. To test the reliability of the handler's detection of an alert on the sole basis of the tonal characteristics, one trial was performed without an ambush (Problem 6, Nero). However, a realistic evaluation of the situation was hindered because a small encampment of soldiers, unaware of the test, had provided a stimulus on which the dog may have given these false alerts.

The significance of the humidity and temperature was evaluated. The first day of the exercise, June 23, both dogs were tested with the temperature ranging from 85-95° F. (Problems 1, 2, 3, 4 - Nero and 1, 2, 3 - Caesar). The utility of the dog seems to be significantly limited under these temperature extremes. His performance and general enthusiasm is markedly reduced; however, his response to an ambush

seems to remain efficient.

From these exercises at Fort Meade, the following considerations were expressed by various persons involved in or observing the performance of the canine reconnaissance system:

1) The distance from the handler to the free-ranging dog is the crucial advantage of the system over a regular scout dog. It generally provides better protection and a longer warning to the handler and the patrol. Also, when the wind is bearing anywhere behind the patrol the free-ranging dog may still give warning. This distance must be emphasized an increased.

2) The radio signal system must be more "readable". We have discussed some of these measures. (Since remedied by the anklet position of the motion transducer.)

C. The ten-day test program.

Incorporating the results of the experience and discussion of the exercise at Fort Meade, a ten-day test program was initiated in the final days of the contract. The purpose of this test was to provide a final evaluation of the level of performance of the system with the most relevant measures of the characteristics of the problem recorded. Three dogs were used in these tests. Caesar and Nero were the dogs used in the exercises described in the previous sections and, the third dog, Slugger, was a fine scout dog trained by the 26th Scout

Dog Platoon. The purpose of including this dog was to determine the efficiency with which a Scout Dog could perform free-ranging reconnaissance and to produce a comparison between scout and free-ranging reconnaissance. He was, therefore, trained for four weeks using the command "STAY" when the handler perceived the dog to be alerting. During the ten-day test, this dog was worked both on and off-leash (as was Nero) but always required to "STAY" on the alert.

Figure 4 illustrates Nero's performance during these test days. The reader will note that on days 2 and 6 some trials were run "on-leash". No significant change occurs under the circumstances as far as the warning the dog allows for himself; however, the handler is at "FA" and not removed to a safer position as in other trials. The advantage of this point are most dramatically illustrated on trial 1, day 1; trial 2, day 2; trial 3, day 5 and trial 2, day 8. On these problems the dog has entered or is beyond the ambush area before giving an alert. However, since the dog is free-ranging ahead of the handler, the handler is warned in time. These characteristics are most likely when there is no wind or an unfavorable wind.

Caesar's performance (Fig. 5) illustrates similar phenomena (see trial 2, day 1; trial 2, day 2; trial 2, day 6; trial 1, day 7 and trial 1, day 8). The three longest trials for Caesar are well over 1,000 yards and this length is indicated by the broken line in those cases. The reader will note that in these light wind conditions, the wind bearing does not always predict where the alert will be. Disruptions in the wind flow by terrain and foliage may account for some of the discrepancy, but most of the scent borne to the dog is probably

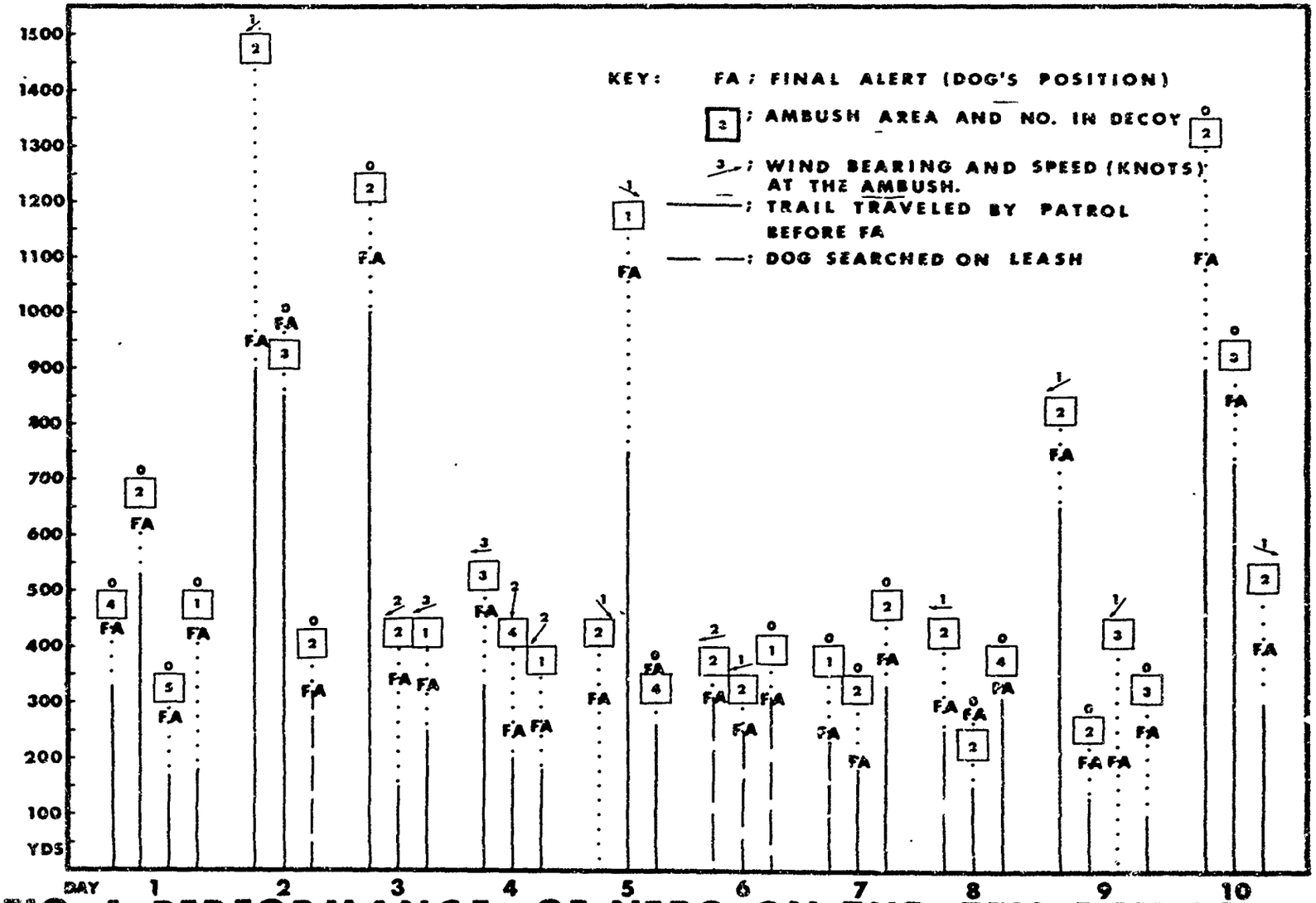

FIG. 4 PERFORMANCE OF NERO ON THE TEN-DAY TEST

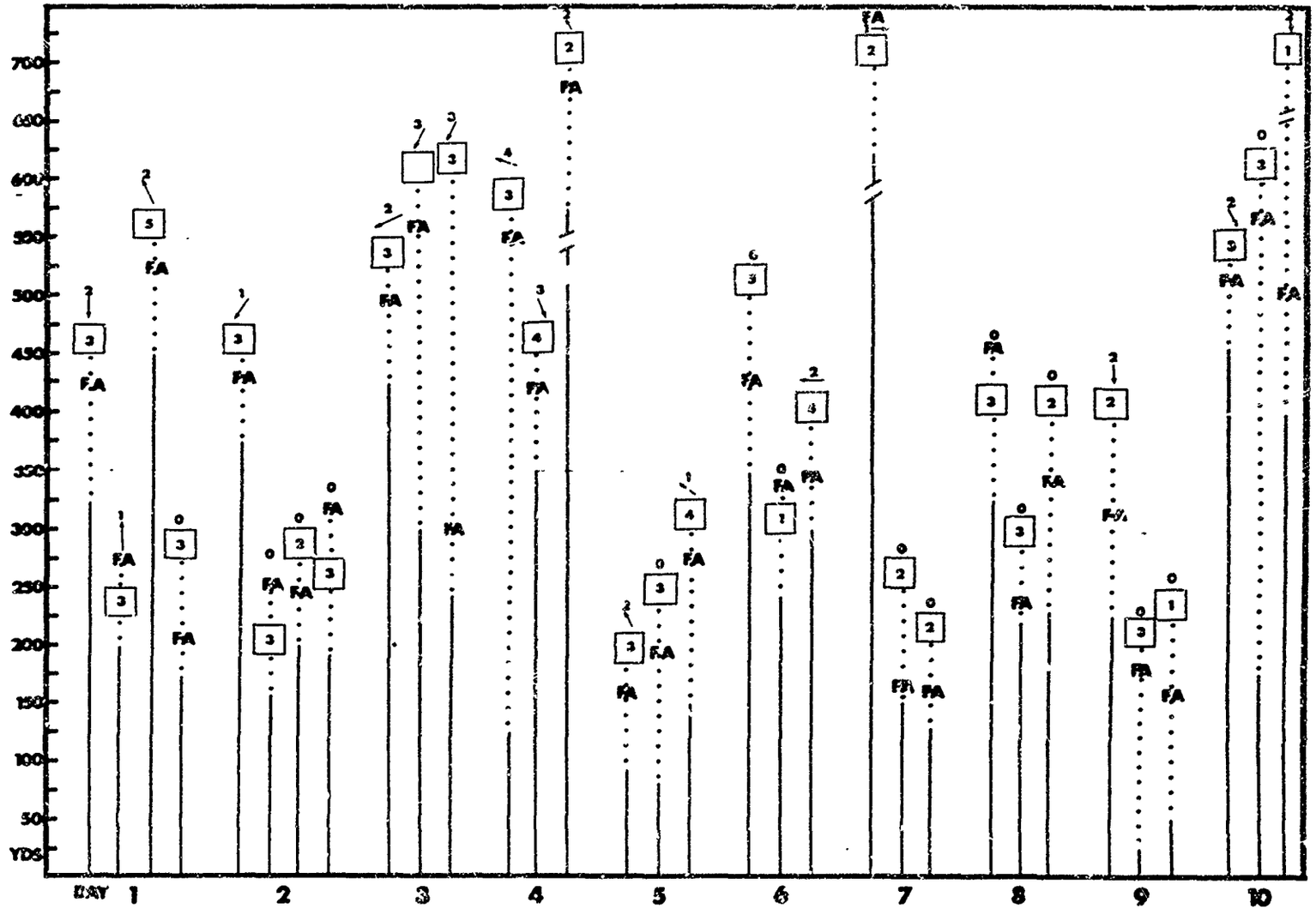

FIG. 5 PERFORMANCE OF CAESAR ON THE TEN-DAY TEST

by general diffusion of it in the ambush area. The performance of Slugger (Fig. 6) was predominately "on-leash" but the "stay-alert" is used. The fact that Slugger never entered an ambush area during the ten-day test is impressive. This may be due to the close supervision from the closely following handler, or it may be that he is just a better performer. In any case, the data suggest (as do those of Nero) that the "stay-alert" can be used with dogs working both on and off-leash.

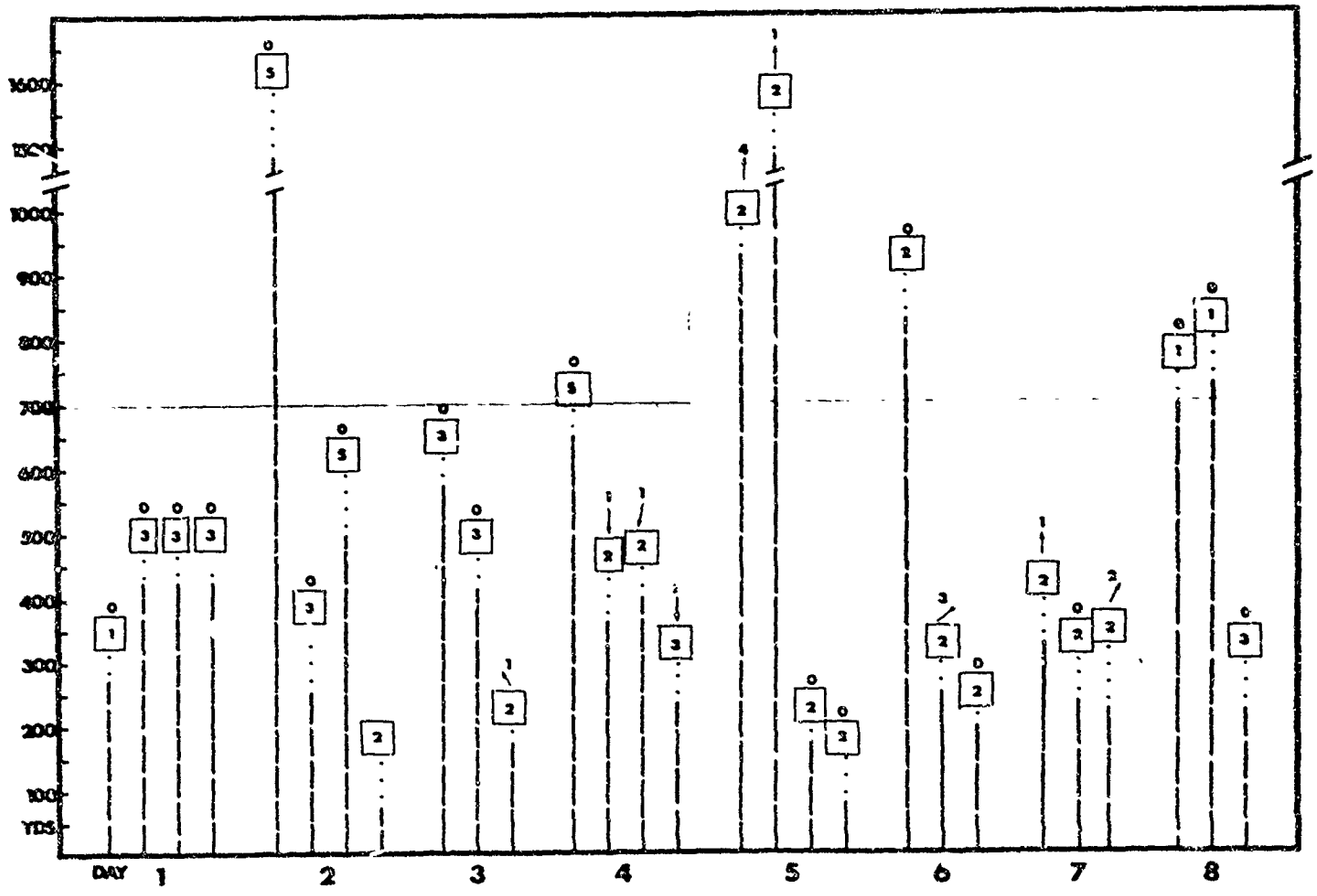

FIG. 6 PERFORMANCE OF SLUGGER ON THE TEN-DAY TEST

PART IV. CONCLUSIONS AND RECOMMENDATIONS.

As has been indicated throughout this report, it is felt that the data suggest that incorporation of some of the techniques of the free-ranging system into the procedures for scout dog training would provide a greater warning and margin of safety for the foot patrol. This margin becomes more and more evident as the wind conditions become less favorable.

The accompanying field manual (Appexdix B) has been forwarded to the 26th Scout Dog Platoon as a suggestion which may be utilized in their revision of the FM 20-20 now going on. This embraces the exact recommendation of the author. That is, that these procedures be viewed as an addiition to procedures now operational. The purpose would be to allow the scout dog more flexibility on a greater variety of military problems. Certainly the logistical problems indicated by such a reconnaissance system are more than justified when effective performance such as indicated in the Tables and Figures of Part III is possible.

The system described in this report is 90% effective in providing adequate warning of the presence of enemy personnel so that the patrol would be protected from an ambush consisting of small arms fire. Its advantage over the present system is in protecting the operating personnel by about 200 yards of trail length. The suggested addition of personnel and equipment (over that now used to operate the scout dog) is merely the addition of the transmitter and motion transducer (see Fig. 2) if standard Army radio communication equipment (38-55 Mhz) is available. The additional training procedures necessary (see Appendix

B) are described in detail would add 2-4 weeks to the present Scout Dog training schedule.

The limitations of the system are as experienced by the Scout Dog system with a few exceptions:

1) Under heavy rain the return whistle cannot be heard and the dog will not return from the alert.
2) When a trail or pathway is not available, the dog must be worked on a leash. If he is not, his direction of search may vary from the direction of the patrol.
3) In heavy vegetation the reliability of the transmitter is limited to 250 yards. If the dog is in advance of more than this distance at the time of the alert, the handler will not be aware of the alert until he has closed to approximately that distance. However, he will be aware of the possibility of an unknown alert since he will be getting no tone (neither steady nor "broken") from his receiver and will realize that he is out of range of the dog's transmitter.

Further possible applications of the system have already been suggested and it is the recommendation of the author that these be further explored in discussion. These include uses of other alert stimuli rather than personnel, such as fence breaks, wire communication breaks and supply dumps. However, when considering other possible alert stimuli, the dog's visual limitations should be kept in mind (see page 5 and 6 of this report). It may be true that a moving visual stimulus

may be more easily discriminated by the dog, but the evidence is no more than heresay. In patrolling a fence for breaks a dog could be kept close to the fence line and his vision would probably be adequate in daylight hours.

The most promising expansion of the use of the system would be to train the alert to other alert stimuli which are still olfactory in nature. Human artifact when handled for extended periods by men holds scent very well, especially if the material is porous such as wooden crates. Therefore, the search problem of looking for caches of weapons, ammunition or other supplies seems the most feasible. The free-ranging dog would have an advantage over the leashed dog in that the handler would not be required to cover all the area that the dog would in his search. The disadvantage is in the extent of position control which could be exercised over the dog. Attempts at position control in the free-ranging system were eliminated by focusing the efforts of this contract on problems with trails, paths or roads as guides for the dog. However, as the 26th Scout Dog Platoon personnel have pointed out, hand signals can be used effectively in positioning and moving the dog. The evaluation of the difficulty of training such a dog would need to be accomplished by those in the Army knowledgeable of the need.

APPENDIX A

TRAINING DOGS FOR FIELD RECONNAISSANCE

INTERIM REPORT

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Aberdeen Proving Ground, Maryland under
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I. INTRODUCTION

Currently a principal military use of dogs is to maintain security of fixed installations.[1] In this situation the dogs work on a short leash, under direct verbal control of a handler. Dogs are selected for this use on the basis of their aggressive tendencies. The functions of sentry dogs are to warn the handler of intrusion and to counter attempted escape. Dogs used for reconnaissance, on the other hand, should, ideally, be released to range freely, and should be capable of functioning in perceptual isolation from the handler. When used in this way a dog should also be capable of transmitting an alerting signal to its handler. The stimulus that elicits the alerting signal must be a consistently detectable component of the field situation. An assumption basic to the rationale of the present study is that human beings are a constant component of the kind of field situation that would be of primary tactical significance in potential operational applications. Other components of field situations may be variable or require excessively precise discrimination for the purpose of this study.

The various tasks required of a dog on a reconnaissance mission can be defined as follows:

A. Leave the handler on command, in a direction indicated upon release;

B. Search for people, hidden and/or camouflaged in varying degree;

C. Signal when one or more people have been located;

D. Return to the handler.

It is assumed that the reconnaissance dog will operate with dismounted personnel.

The task sequence outlined above is complex. Analogous tasks, however, are accomplished by several breeds of working dogs, particularly by hunting and herding dogs. Admittedly, the functions of working dogs are different from those of a reconnaissance dog. In all instances, however, working breeds have been developed to perform functions of varying complexity at some distance from the handler on the basis of simple auditory or visual cues. These often difficult tasks may be completed out of sight of the handler.

The results obtained in the present study demonstrate the feasibility of using dogs to reconnoiter in free ranging for the purpose of detecting people in hiding. The training methods developed in this study are readily adaptable to the requirements for large-scale training procedures to produce reliable reconnaissance performance in any desired number of dogs.

Methodology

Behavioral analysis. Modern behavioral analysis provides a methodology to achieve a hitherto unattainable degree of experimental control over animal behavior in the laboratory.[2] This methodology has been exploited to produce dramatic performance in many different species in applied situations.[3] The methodology is often referred to as operant conditioning, or instrumental behavior analysis.

Behavioral analysis deals with observable responses of an organism, the effects of the responses on the environment, and the consequences to the organism of these environmental changes. The principal datum of interest in the application of operant conditioning techniques is the frequency of occurrence of an acquired response, or of sequences of responses, as a function of (1) consequences of the specified behavior, and (2) the stimulus conditions under which the response is made.

Consequences of behavior. The consequences of behavior may occur "naturally" in the environment, e.g., a dog trailing a rabbit - catching and eating the rabbit are terminal consequences of the tracking behavior. In the laboratory the consequences of behavior may be explicitly programmed by an experimenter and mediated by appropriate apparatus. Thus, for example, a rat may be trained to operate a lever-action switch by the programmed delivery of food pellets when a specified lever-operation requirement is met. The consequences of behavior may be positive or negative.

Positive consequences, or reinforcements, increase the likelihood of further occurrences of the preceding behaviors. In lay terms, reinforcing events are called rewards. Negative consequences are those events which, when presented, decrease the likelihood of occurrence of the preceding behaviors. These events are called punishment in both technical and lay vocabularies.

Reinforcements are of two kinds, also termed positive and negative. Positive reinforcements are those consequences which enhance behavior when they are presented following the response. Thus, food, water, sex, money, praise, etc., are examples of positive reinforcers. Reinforcing a response increases the number of responses made in a given unit of time, or the response rate. Conversely, extinction, i.e., non-reinforcement of a response, tends to reduce the probability that a response will occur. Negative reinforcements (not to be confused with negative consequences) are those consequences which enhance behavior when they are withdrawn following the response, for example, painful stimuli, verbal abuse, or other stimuli associated with the absence of positive reinforcement.

Aversive stimuli may be used to facilitate learning and performance in three ways; (1) an animal is taught not to make an undesirable response by applying an aversive stimulus after each occurrence of the unwanted response (punishment); (2) an animal is taught to make a response by applying an aversive stimulus until the desired response occurs (escape learning); (3) an animal is taught to make a certain response under threat of receiving an aversive stimulus (avoidance learning). The difference between negative reinforcement and punishment is in the function, not the kind of event. For example, painful stimulation is a negative reinforcer when its removal is contingent upon the occurrence of a desired response, and it is a punishment when its presentation is contingent upon the occurrence of the response. In general, in the latter case, the response is produced by the withdrawal of a stimulus, whereas in positive reinforcement, a response is produced by presentation of the stimulus.

The use of aversive stimuli can be very effective, but it may also produce undesired side effects. In a complex situation, punishment for incorrect responses may suppress all responses. Negative consequences frequently tend to arouse emotional responses (conditioned emotional responses) which are incompatible with performance of a wide range of behaviors.

Stimulus control. Stimulus control is acquired through the differential presentation of positive and negative consequences in the presence of previously neutral (not specifically conditioned) stimuli. Initially the stimulus acquires positive conditioned reinforcement properties by simultaneous presentation with food or some other reinforcer or negative properties by pairing with a negative reinforcement. The response, previously trained, can be brought under stimulus control by reinforcing all appropriate activity during the period the stimulus is presented. When the stimulus is withdrawn, the absence or a response, either correct or incorrect, may be rewarded. Thus, an animal learns to respond when the stimulus is presented and not to respond when the stimulus is withdrawn after a period of training or experience in the training situation. When this occurs the response is said to be under stimulus control. The subject has learned to differentiate (discriminate) between the presence or the absence of the previously meaningless stimulus, and to respond appropriately. This rationale was applied in the present training situation. In accomplishing the reconnaissance function, the object of the dogs' search must be a stimulus that is sufficiently powerful to elicit the required "information response" in the field.

II. MATERIALS AND METHODS

Five pairs of normal male dogs were initially purchased. They were Labrador Retrievers, German Shepherds, Beagles, Blue Tick Coon Hounds

and mongrels (mixed breeds). Where possible, American Kennel Club registration was required to obtain genotypes as homogeneous as possible. Supply sources for dogs and other materials used in this study are listed in Appendix C.

Labrador Retrievers are hunting or gun dogs, German Shepherds are herding dogs and the Beagles and Coon Hounds are trailing or ground scenting dogs. The mongrels were used to assay the effects of variable and largely unknown genetic mixtures. The dogs purchased represent a small sample of animals available through normal commercial channels. No attempt was made to select dogs on the basis of any criteria other than breed, sex and age.

Young adults (one year of age) were necessary in order that the weight of the equipment could be carried without undue discomfort. Previous history of training was available only on the Retrievers. This training was in basic obedience (come, sit, stay, heel) and rudimentary Retriever training (fetching a thrown cloth dummy). Retained performance of these tasks at the laboratory was poor when tested. This is not to say that the dogs had not learned the commands only that the commands when given by a complete stranger elicited no response from the subjects. All other dogs tested in a similar manner for possible training reacted in the same way to the commonly used verbal commands. Typically, the response consisted of inattention to the command. It was assumed that all of the dogs were essentially naive in the laboratory setting.

The dogs were found healthy and were given routine prophylaxis against pneumonia and internal parasites. They were allowed to adjust to the new situation and diet for one week prior to being placed in the training situation.

Housing for the animals was provided by 50-gallon steel drums with one end removed, mounted horizontally on a two-inch pipe sunk in the ground. The pipe projected 18 inches to 2 feet above the ground. A 6-foot chain with a loop around the pipe allowed the dogs a circular run of approximately 100 square feet. A canvas flap was fastened to the open end of the barrel.

The dogs were maintained on a commercial dog food (Purina) and a milk concentrate powder (Red Rose). This diet supplemented food received in the training situation.

Training apparatus

Command system. It is necessary to cue or present stimuli to the dog to indicate that a change in behavior is required. Some means, therefore, of reliably presenting a cue to the dog was needed. Since the subjects would ultimately be out of sight and hearing, a radio transmitter was selected that

would enable the handler to broadcast several radio signals. A dog-borne unit was devised to receive and convert radio signals into audible cues (commands) through a speaker. Because the dogs' unit must also transmit a signal to the handler when the search object has been found, a dual transmitter and receiver was provided. A complete description of the radio units is presented in Appendix A.

Harness and pack. The dog-borne components of the radio system were carried by the dogs in a canvas saddle bag strapped to a harness which was secured to the animals by buckles and straps.

Stimulus object. A wooden cube, one foot on a side, painted black, was selected as the stimulus or search object. The box was tested for neutrality by placing it in an open field and allowing the dogs to approach it in a free choice situation. The dogs investigated the box, but the time spent near it was no more and no less than time spent investigating other objects in the environment. This behavior strongly suggested that the box was free of positive or negative associations and that the dogs had no previous training with objects of similar physical properties.

Human beings were not used as search objects early in the program because of the conditioned reinforcement properties they have assumed in the dogs' history.

The box was, therefore, chosen as a reasonable stimulus which would serve as the search object in the experimental training program. Later studies proved that the transfer to the human figure presented no special problems.

Observation of the dogs' activity in the field suggested the large role olfaction plays in locating an object. Characteristic odors appear to be relied upon when vegetation and terrain complexities and distance preclude direct observation and straight line approach to the object of search.

An arbitrary scent was added to the box to assist the dog in locating or restricting his search to an area where the odor was most concentrated. Originally, oil of wintergreen was used to "label" the object, but use in the field indicated that the potency or concentration of this scent was too quickly dissipated. Oil of anise was substituted and found to be satisfactory - adequate potency was maintained for a full two hours and a residual odor was detectable at 2 feet for as long as 3 days.

Information response mechanism. The utility of a scout dog would be increased if there were some reliable method of obtaining information from the dog during periods of visual and auditory contact loss. Previously mentioned has been the general task outline, and the use of radio transmitters to broadcast information to and from the dog. Conceivably the dog could be

trained to make a switch closure in proximity to the search object which would activate the transmitter.

A number of devices were examined for possible use as a transmitter activating switch.

A review of various movements that a dog is capable of making was first undertaken. These movements were evaluated with respect to their possible utility in being adapted to operate a switch mechanism. The movements that were evaluated included tail wagging, scratching with the rear limbs, head turning or head lowering, pawing with the forelimb, biting, pushing with the nose, barking and sitting motionless. The premise was that any of these movements could be used, with a suitable intervening mechanical or electrical device, to activate the transmitter.

There were limitations placed upon the response chosen. First, it had to be sufficiently general so that any dog chosen was capable of initiating and completing the act with sufficient force to be ultimately converted by the transmitter into a detectable signal.

Second, the response could not occur with a significant probability prior to training. It had to be sufficiently unique so that when the signal was received by the handler there would be a high degree of assurance that this was not accidental. Sitting motionless and tail wagging are examples of responses which could occur in the field under a variety of conditions. These would give false positive reports and, therefore, could not be utilized.

Switch mechanisms. The choice of dog signal relay system (radio transmission) required an electrical change of sufficient strength to be converted to a transmittable signal. The signal could be generated by the response acting directly on electrical contacts or initiated by an intervening mechanical device.

A review of possible switch mechanisms included push buttons, lever action microswitches, accelerometers (steel ball falling in a viscous fluid) mercury switch, magnetic reed switches, carbon granules (compression causing decreased resistance), metal plate contact and stable oscillation interruption.

The mechanism chosen had to be waterproof, and it could not fail because of mechanical jamming by vegetation. Small size was desirable to preclude snagging, and preferably the switch would be easy to attach and remove from the dogs.

The location of the switch on the animal would be determined by the response chosen. The switch had to be adaptable to the part of the anatomy used by the animal to make the response. The switch could not be mounted on the animal in a way that would be in any way detrimental to the animal's locomotion.

Bite response. A bite response was chosen for its low probability of occurrence in the field, high degree of generality in all dogs and a dogs' ability to reach the greatest portion of its anatomy with its mouth. The switch was a camera shutter release bulb driving a plunger which closed a microswitch. The pressure required to activate the plunger-microswitch device was four ounces. The bulb-plunger-microswitch apparatus was originally located in the flank region. The bulb bite response, the bulb switch mechanism and the location of the switch were changed during the training period when difficulties arose. These will be discussed under Training Methods.

Training Methods

The methodology of modern behavioral science has been discussed. The techniques require the use of a reward or reinforcement presentation following each desired response. Throughout the training period food was used as the primary reinforcer. Two factors affected the level of motivation in the training session. The primary factor was the number of hours of food deprivation. The second factor was change in the character of the reinforcer. This was most obvious when a change was made from dried food to a canned preparation.

Food deprivation. The original deprivation schedule used was based on 80% of ad libitum weight. This proved too stringent for animals housed outdoors and one animal died from complications believed to be associated with this amount of weight loss. The problem of sufficient motivation was compromised by the general state of health of the animal. Shorter sessions (fewer trials per day) were accepted in order that adequate levels of nutrition could be maintained. Twenty-four hours of food deprivation were insufficient to develop a satisfactory level of motivation, though a short (5 - 10 trial) session could be obtained. Thirty-six to forty-eight hours generally permitted a sufficient number of trials (20 - 30). Allowing the dog to work to satiation in this period resulted in lowered performance on the next day, but a return to high performance the second day. This level of deprivation was adequate for most situations, but occasional periods as long as 96 hours were necessary to correct a persistant fault or to train a difficult task. It should be emphasized that this level of deprivation (approximately 48 hours) is necessary only during the introduction and early repetition of a new task. Once the task is learned, 24 hours deprivation gave adequate performance.

A number of different foods were tested for their value as a reward. Gainsburger, canned mackeral, raw hamburger, canned horse meat, cooked liver, milk and Gaines Meal were used at various times during the training period. The most consistently reinforcing food was the canned horse meat, Gainsburgers were al most as palatable and had the additional advantage of being less trouble to dispense. All other food showed some novel effect but then decreased in strength. The results of quantitative changes in reward were inconclusive. In general the reinforcements were kept small in size (2 - 4 oz.) in order to maximize the number of trials per session.

Obedience training. Traditional methods of dog training were used to establish obedience. Simple verbal commands such as sit, heel, come, stay, were taught to four of the dogs. Training was accomplished by means of a choke collar. Failure to respond or an improper response was followed by a sharp tug on the leash (punishment, and later, avoidance); correct responding was rewarded by petting and vocal expressions of encouragement.

Verbal control was obtained over four of the dogs to some degree. The verbal control was of some use in the training procedure. Frequently this use was a convenience; e.g., sit and stay command given prior to buckling on the harness or heel command when taking the subject to and from the kennel to the training area. The command "come" was paired (simultaneous presentation) with the return tone in one phase of the training. The return tone gradually replaced the verbal command "come" by the process of pairing and incremental decrease in the loudness of the spoken word "come" (fading).

Retriever training. Retriever training is an extension of obedience training. Auditory and visual cue control become established over increased distances. The dog learns to complete increasingly complex tasks over distances of 100 yards or more. Behavior is maintained through a system of positively associated words (good dog, etc.) and negatively associated words (no, bad dog, etc.) and punishment. The main task, retrieving a thrown canvas boat fender, is made increasingly difficult until hand signals and a series of whistles are required to convey information to the dog over long distances. Starting, stopping, and left and right directions are given by these methods to confine the dogs search to a small area near the dummy.

Directional control is achieved eventually by arranging the training situation into easily completed tasks with an arm signal to indicate the bearing to the dummy. The dog will learn to take a straight line to considerable distances and with practice circumnavigate obstacles in the terrain and resume the line on the other side.

Reconnaissance Training. The critical difference between the retriever task and the proposed reconnaissance dog task is that the handler has foreknowledge of the location of the search object in the retriever task. Originally, it was thought desirable to have strict directional control over the dog to place him accurately in an area of possible stimulus concealment. Tests of the handler's ability accurately to predict the location of the search object in a limited environment (a one acre enclosure), however, gave results that were no better than could have been achieved by random searching. On the other hand, it is recognized that in other field situations there may well occur terrain features that would represent preferential sites for concealment of people, and that these might be identified by experienced personnel.

After consideration of the various factors involved in this problem, it was decided not to attempt to develop strict placement control of the dogs, at least in the original program. If it is assumed that the handler cannot reliably predict the most probable location of hidden people in a field situation (and if he could there might be no requirement for dogs!), then it is completely valid to attempt to establish a generalized search pattern. This could mean, in effect, that the dogs are allowed to establish their own patterns, once they learn what they are supposed to do when released. In practice, the dogs readily developed a "casting" technique, in which they searched back and forth along a swath of varying width and length.

The various stages in reconnaissance training was described below.

a. Release and return. The first phase of training was to arrange a situation which would encourage the dog to leave the handler and travel some arbitrary distance from the trainer and return under tonal control. This series of experiments explored the possibility of controlling the direction and distance of a dog's running, fulfilling the first and fourth components of the complete task.

The dog was familiarized with the availability of food at a mechanical feeder by allowing him to eat at the site several times. The sound of a tone at the same time or briefly before food was made available at the feeder, conditioned the dog to go to the feeder at the onset of the tone. Later, when the dog is out in the field this tone will cue him to return to the base because his previous experience in the presence of this tone means a reward is available.

A steel wire was strung between two trees, about 50 feet apart, and 5 feet above the ground. The magazine and food pan were located at one end of the wire and the dog's leash was loosely connected to the wire. Excursion

along the length of the wire was allowed, but lateral deviations were limited by the leash. A tone was initiated and any movement away from the handler or base caused the onset of a different tone which was associated by previous magazine training with food. The distance traveled on the wire was gradually increased until full length excursion of the wire was achieved. Four dogs were subjected to this procedure and all showed difficulty in learning the task. Only one dog of the four tested gained sufficient level of performance to be released from the wire. An attempt was made to correct errors of premature returning by the use of a shock collar in this phase of training. The side effects of punishment became apparent in three dogs subjected to shock, taking the form of cowering or violent attempts to escape.

An alternative procedure was next followed. Four dogs were trained to pick up and then retrieve a thrown object, returning it to the handler. When this was well learned the box was substituted for the thrown object and by appropriate pairing, tones were introduced to replace the hand and whistle signals used initially. This method was effective in teaching or inducing the subjects to approach the box. The time necessary to teach first the retriever task and then the transfer to the box, made this training method excessively long.

A third technique proved more successful. Dogs were trained to approach the box (search object) by baiting it with small portions of food. Two tones were broadcast: the first while the dogs approached the box and the second after the dogs had reached the box. The second tone was the one previously taught during food magazine training and hence it came to function as a return signal.

The initial distances to the box were short (3 - 6 feet). The box was gradually moved further away and the baiting was decreased in frequency. Distances of 60 yards were achieved with this method and searching behavior was evident when the box was hidden. The direct box training with intermittent baiting as the performance improved, appeared to be the fastest and most reliable method of training the animal to seek out the box.

b. Information response. The general problem of selecting an information response has been discussed. A pneumatic camera shutter release mechanism driving a microswitch was developed for use in the field. A series of training procedures to teach not only responding but responding in the presence of the search object was devised. The previous training experience was used as a foundation for more complex behavior wherever possible.

A number of techniques were tried and discarded in an attempt to train and maintain bulb biting behavior. Six techniques were tried; retriever

training, elusion or teasing, restraining box, direct shaping, plastic squeeze toy, and a milk-soaked sponge containing electrodes. All these methods were used to induce biting an object with sufficient pressure to close the microswitch. The pressure required to close the microswitch was 4 ounces. Consistent closure was achieved in only 3 of 10 dogs after training periods up to 3 months. An additional difficulty with the bite response was that the distance to the box became a critical factor in the emission of the bulb bite; i.e., the greater the distance to the box, the lower the probability of the response occurring.

As an alternative to the bite response, the microswitch closure mechanism was modified to function upon pulling a flexible wire attachment. Although the two responses are similar, the pull response proved easier to train, and much easier to maintain. The dog grasps a small polyurethane sponge mounted on the end of the flexible wire and pulls. For training purposes the switch closure activated a horn to signal switch functioning. Initially the response mechanism was mounted on a portable platform. Later it was moved to the harness. Seven dogs learned the pull response and transferred to the harness without difficulty. Transfer to the harness was assisted by tying the sponge on a string which hung 4 - 6 inches below the harness. Graded shortening of the string during the session brought the sponge to its final position at the shoulder.

c. Sequential performance. The goal of this phase of training was to establish an appropriate sequential chain of behavior incorporating in the proper order, searching, performing information response upon location of search stimulus, and returning to starting point.

Two dogs were trained at the kennel site to perform the information response in the presence of a tone. Responses emitted when the tone was off were not rewarded. Soon the onset of a tone would elicit an immediate response, whereupon a second tone would be turned on and the dog was fed. A box was introduced and the dogs were allowed to approach and when within 2 - 3 feet of the box the first tone was turned on, responding occurred and was properly reinforced. Leaving the box without responding caused the tone to be discontinued and no reward was given. The subjects learned to approach the box, and later a human, in order to turn on the first or response tone. Eventually, as the experience with the procedure developed, the first tone onset was delayed and responding occurred spontaneously with the approach to the search object. This alteration occurred smoothly so that by the time the subject was beyond sight of the handler the proximity tone was unnecessary.

A later modification of this procedure proved highly effective in establishing several components of the task in the correct sequence. In this "alternation procedure", the previously learned pull response is encouraged at both the box and food pan, which, initially are in close proximity but separated by a baffle. At first, rewards are given at both the box and the pan, so, in effect, there are no incorrect responses. Pan responses are gradually extinguished until only responses at the box remain. No negative or aversive stimuli are used in this procedure. As training progresses, the box is removed further from the starting point and the baffle is faded out.

The basic components of the task may be learned in a relatively short time, but the performance frequently is marred by slow running speed, long pauses prior to responding after locating the search object, and occasional returning without responding after sighting the box. Three manipulations were of value in correcting errors of this type.

(1) Scheduling. The subjects were required to repeat the task several times (as high as 8) prior to being rewarded once. The variable interval of reinforcement tended to sustain high levels of performance; the effect of practice (repetition) is also beneficial in this schedule. There was a marked increase in running speed and a decrease in both errors and latencies (time spent near the search object prior to responding). Higher schedules began to elicit the characteristic pause prior to starting the chain, such as is seen in the laboratory. This was particularly true when the distance to the search object was 100 yards or greater.

(2) Inter-trial interval. A completed correct trial was the occasion to detain the dog for one minute prior to initiating the next trial. This pause had some affect on the speed in searching for the box. Aside from spacing the reward interval, there was a definite increase in anxiety manifested by tugging at the leash, whinning, and scanning movements of the head. Resease of the individual in this state revealed good running speed to the object.

(3) Time-out period. This was used on some individuals as punishment for consistent errors, generally of a distractive nature. The animal was restrained on a short leash in the area the error occurred and left alone for intervals of five minutes or longer. Anxiety was manifested by barking and leaping, and once released, the performance was improved in the ensuing trials. This beneficial effect was not constant throughout the session, nor was it consistent with all dogs (more effective with socially dependent dogs) but it did allow mild negative contingencies to be placed on unwanted behavior.

d. Searching for humans. Human beings were introduced into the training program by each of two methods. Both methods appeared equally effective.

The first method (pairing and fading), consisted of placing a person near the box, then sitting on the box, and finally removing the box entirely. This was done with relative ease. The substitution of humans as the search object improved the overall performance considerably in several dogs. Greater distances were achieved without the loss in performance seen when the box was moved a similar distance. The opinion that training to search for humans would be an easier task was verified.

In the second method (proximity tone), the technique described earlier, in which correct responding behavior to the box was shaped with the aid of a tone (section c), was used with one animal.

Performance was good throughout the training period and larger changes in the training sessions (increasing distance, radical changes in environment and changes in direction of search) indicated the advantageous properties man has assumed with regard to the dog's search pattern.

e. Final training format. Two naive dogs were obtained for the purpose of testing a training schedule evolved from the experience gathered with the ten original dogs. The following order of training proved to be both rapid and reliable when tested on naive dogs.

(1) Response training. Train the subject to make the information response first, in this case a pull response. In this period, with the use of a tone following the switch closure, magazine and return tone training are concomitantly taught. The response is also transferred from the platform to the harness during this period.

(2) Discrimination training. Train the information response specifically to the presence of the search object. This can be accomplished by either alternation procedure or by proximity tone.

(3) Increasing distance to the search object. The procedure up to this point could probably be automated and done at or near the kennel site. Once the distance to the search object was increased to 10 to 20 feet it appeared beneficial to move the training outside the compound to a wooded area and begin giving the dog as much experience with varying terrain conditions as possible. The shifting of personnel both as handlers and as search objects appeared to be imperative at this time also. Essentially, what was attempted was generalization to terrain, handler and search object (not dependent on an individual or specific environment) before a set pattern was established and "restraining" to new situations was necessary. This was not completely achieved with the new dogs, but sufficient evidence was obtained to indicate that this method is practical. The most valuable information from the training of the new dogs was the fact that going out and returning training could be dropped from the program and that searching behavior could be instituted by simply moving the search object away

from the base. Directional control is achieved by using a hand signal to give a bearing or straight line to the search object. Rotation of the search object 360° about the base at varying distances gives additional experience in taking a line.

III. DISCUSSION

A training procedure was developed which would maintain complex performance by a dog in the field over distances of 100 yards or more in wooded terrain (visibility less than 25 yards). Concomitant with the trained performance was the development of a radio transmitter-receiver system which allowed information to be passed between the handler and the dog (see Appendix A). A specific response was trained to be given when the search object was found. This response activated a transmitter borne by the dog and was interpreted as a tone in the handler's receiver.

The following scheme shows the possible meanings of the dogs' information response:

	Response	No response
Box Present	True Positive	False Negative
Box Absent	False Positive	True Negative

The response was trained to be given only in the event of positive identification of the search object. In the absence of a response, the handler has a choice of two assumptions, as shown above: ((1) there is truly no search object in the area of search (true negative), or (2) there is a search object in the area of search that was not located (false negative). When a response is made, the handler again can make either of two alternative assumptions: ((1) the search object has been found and identified, or (2) the dog is confused, is attempting to cheat, or an accidental closure of the switch has occurred.

During the training period it was possible to examine all of the above possibilities. Responding in the absence of the box was very low in the majority of dogs and generalization to other objects ((a blackened tree limb of the same size as the box, or a dark rock) did not occur. Occasional false negatives were observed and in some cases appeared to be wind dependent

(the subject would pass close to the box and would find it on the down wind side). Sustained searching for as long as fifteen minutes was frequently observed; longer intervals were generally interrupted by the dog returning close enough to establish visual contact with the handler and then returning to search the area again. The search pattern was characterized by a casting left and right of the bearing originally given. The widest sweeps occurred at the farthest distance away from the handler. Sustained search with back-and-forth casting were more frequently observed when the box, rather than a human, was used as the search object. The human, by virtue of its size, was more difficult to conceal in the terrain that was utilized in the early tests. Attempts were made to confuse the dogs by placing the box 3 to 4 feet above ground level. In each case the box was located without difficulty, and the correct response was made.

Breed differences. The methods used proved to be most effective in training the Labrador Retrievers and the German Shepherds. The hound group proved to be less amenable to the training methods used. There was sufficient variation between individuals in this small sample to make no clear-cut distinction possible between the Retrievers and the Shepherds. The best dog, based on all-around performance, was a Labrador Retriever. On the other hand, this dog took slightly longer to train to a given task and was more handler dependent than the Shepherds.

Weather. The final task was not completely trained until early summer. The training of component parts of the task had occurred throughout the year. In that period training in rain, high wind, and snow storms gave some indication of performance under adverse conditions. The most consistently detrimental weather conditions were high temperature and humidity. Temperatures over 85 degrees had a decidedly adverse effect on the dogs' activity. Appetites were depressed and all subjects tended to seek cooler shelter after short working sessions. There was some slight indication of acclimatization, but this did not make up for the original decrement.

Distractions. During training sessions helicopters frequently flew overhead and trains passed on nearby tracks. At no time did these sounds interrupt the training or appear to frighten the dogs. These and other potentially distractive occurrences were well tolerated, probably as a function of habituation.

Physiological telemetry. The possibility that a dog might be killed or otherwise incapacitated while performing a search was considered. A review of physiological functions that could be telemetered to provide continuous monitoring capability was undertaken. The results of this review are presented in Appendix B.

Brain stimulation. Two animals were prepared surgically to receive brain stimulation as a reinforcement. One of the animals had been trained originally with food as the reinforcement and the other was naive. Aside from the technical difficulties involved with leads, correct placement of electrodes and wound management, this method shows some promise as a method of quickly training the subject.

IV. SUMMARY

1. The use of dogs to search an area and to initiate a warning radio-transmitted signal when a human is present in the area of search is feasible judging by the performance of dogs trained in a model field situation.

2. Radio equipment to receive and transmit the required information can be developed from commercially available components.

3. A training method utilizing contemporary techniques of behavior conditioning and control was developed.

4. The training method that was developed can be readily adapted for use with large numbers of candidate dogs.

5. A physiological telemetry system to telemeter heart beat was explored and found to be feasible as a method of monitoring the physiological integrity of dogs while searching (see Appendix B).

V. LITERATURE CITED

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V.H.F. Radio Command System

I. INTRODUCTION

Paragraph 19.31 of Section 19, Rules and Regulations, Vol. 6, February 1962, Federal Communications Commission, provides the following frequency allocations for "the control of remote objects or devices by radio, or for the remote actuation of devices which are used solely as a means of attracting attention":

26.995 Mc/s
27.045 Mc/s
27.095 Mc/s
27.145 Mc/s
27.195 Mc/s
27.225 Mc/s

To simplify equipment licensing, all transmitters were purchased commercially. Transmitters purchased appeared on the F.C.C. list of type-approved transmitters as provided for by Paragraph 19.43 of Rules and Regulations. No modifications to the transmitters were made which would violate or nullify the acceptance of the transmitters by the Federal Communications Commission.

Transmitters were modified model aircraft radio control systems manufactured by Citizen-Ship Radio Corp., Indianapolis, Indiana. The purchased systems were transistorized, lightweight and fully compatible with the other modules comprising the command radio system.

II. BASE STATION

The purpose of the base station is to generate and transmit all information to the animal, and to receive and process all information transmitted from the animal.

Although referred to here as a base station, the unit is actually portable, and, including all batteries, has a total weight of 10 pounds. The portability and freedom from external power sources allows the base station to be transported to any remote testing area and quickly set up near the handler.

The base station is divided into two separate cabinets. One cabinet houses all equipment necessary for transmission of information to the animal. The other cabinet contains all equipment necessary to receive signals transmitted from the animal.

The antenna system is a telescopic vertical whip integral with each case. No other external antennas are required.

Two separate cases were used so that with a physical separation of approximately fifteen feet, simultaneous transmission and receptions could be used with a minimum of inter-channel interference.

In future base stations, greater frequency separation between transmitting and receiving channels would eliminate the necessity for two separate cabinets.

Base Station Transmitter.

Power: 100 milliwatts.

Modulation: emitter injected Amplitude modulation.

Frequency: crystal controlled 27.195 Mc/s.

Command Channels: ten stable sine wave frequencies from 200 to 2,000 cps.

Keying: continuous carrier. Keyed command tones, relay operated.

Controls: hand held switch box; 15' cable to transmitter.

Command Channels:

Group A: 9 distinct audio stimuli using 3 basic tones (on dog) in time pulsed combinations.

Group B: Operation of devices in remote harness.

1) two channels used for a bistable relay circuit (no longer used).

2) one channel - to actuate Brain Stimulator.

Group C: Four channels - unused spares.

Base Station Receiver.

The base station receiver is a crystal controlled (27.095 Mc/sec) superhetrodyne receiver mounted in a portable cabinet with integral power supply and antenna system. The received signals are presented audibly through a 4" loudspeaker mounted in the cabinet. No attempt was made to use decoding circuits in the base station receiver to eliminate spurious reception since the received signal was easily distinguishable from background noise and extraneous transmissions. It is recommended, however, to include decoding circuits in succeeding equipment so that a light or other display device (tone, buzzer, etc.) will be actuated when the animal has responded in the field. This modification would serve two purposes:

1) elimination of possible operator distraction by receiver background noise, and

2) would allow other information, i.e., physiological data, to be multiplexed with the response information and processed internally, without the operator having to discriminate between the normal and the multiplexed signals.

Power supply: self-contained rechargeable batteries.

III. ANIMAL MOUNTED APPARATUS

The function of the animal mounted equipment pack is 1) to provide auditory stimuli for the guidance of the animal, and 2) to transmit a signal to the base station when actuated by the dog. It is also capable of providing pulses for brain stimulating electrodes.

Limitations.

There are several equipment limitations unique to the application of radio apparatus mounted on a free ranging animal.

1) Size and weight must be tailored to the dimensions of the animal. Even more important, the weight must be distributed in such a manner as to prevent shifting of the harness from side to side.

2) Power supplies must be lightweight and still have a long operating life between battery charges or battery replacement.

3) Severe mechanical and environmental stresses must not affect the operation of the equipment. A running dog can produce a high level of mechanical stress on the radio gear. Space and weight limitations do not allow the use of shock mounting for critical components as is standard in vehicular equipment.

4) The equipment must continue to operate under severe environmental conditions, such as the dog running through water and mud, rain and snow falling on the equipment, etc.

5) Physical limitations prevent the use of highly efficient or large antenna systems. Establishing reliable communications paths becomes a major factor in the overall efficiency of the communication system.

The equipment in use now has been able to withstand the environmental and mechanical stresses mentioned above and is functioning satisfactorily.

Interference.

Normal field application of portable receivers does not require as strict control over volume consistency and intercommand silencing as does transmission of audio stimuli to an animal subject. The radio frequency spectrum near 27 Mc/s is densely populated with spurious transmission. To eliminate variations in audible stimulus volume, the auditory stimuli are generated within the animal-carried equipment, and the radio is used only to turn the audio tones on and off.

An additional advantage that is gained from the use of internally generated tones, is that the radio receiving apparatus may be used to actuate other equipment in the animal pack, such as a brain stimulator, transmitter tester, etc. In operation, the loudspeaker contained in the animal harness remains completely silent, except when the command signal is given. A stimulus tone is then heard at a constant pre-set volume.

A block diagram of the animal mounted system is shown in Figure 1.

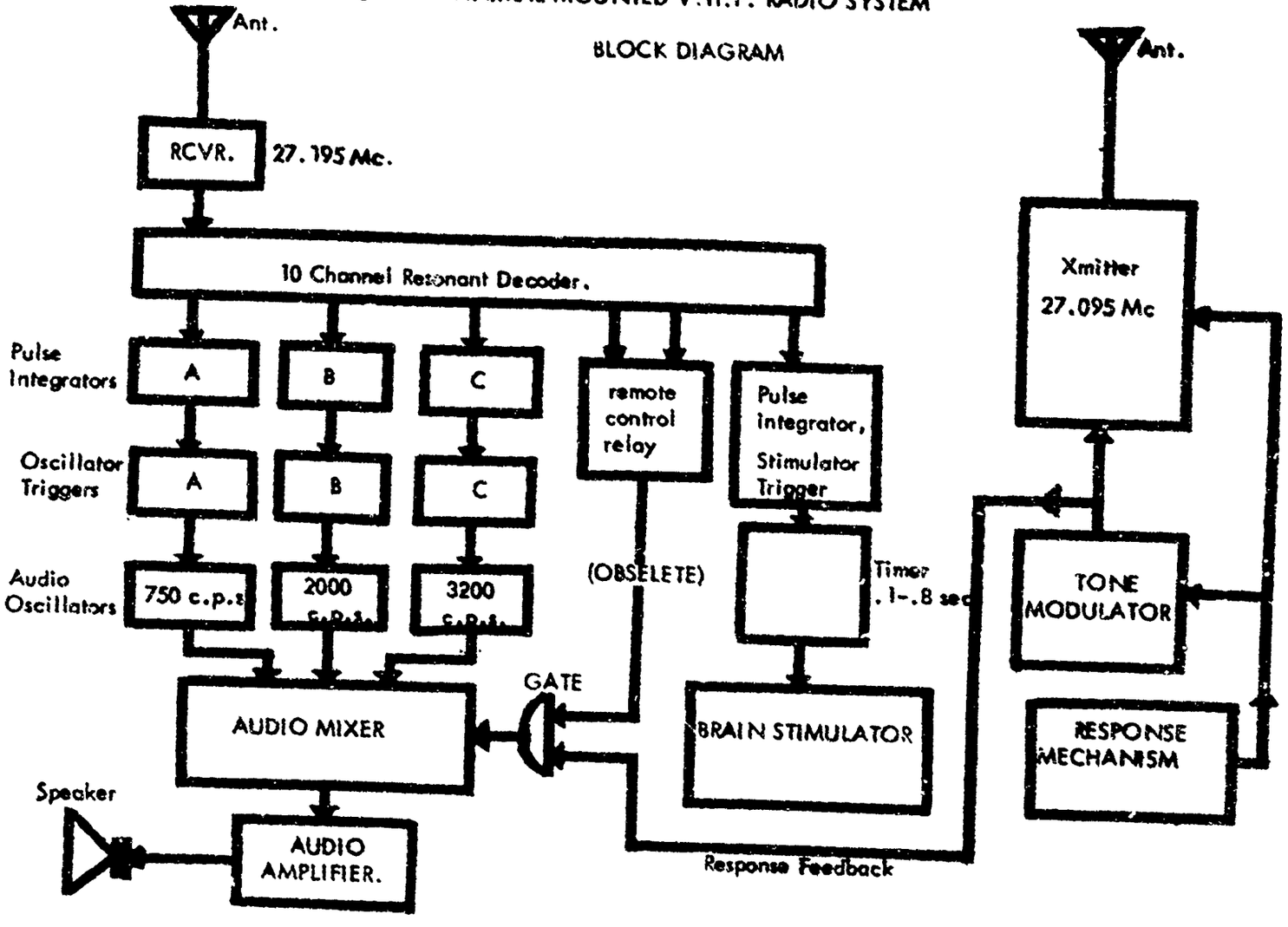
Command Receiver.

Frequency of operation: crystal controlled, 27.195 Mc/sec.

Type of receiver: superhetrodyne.

Fig. 1 - ANIMAL MOUNTED V.H.F. RADIO SYSTEM

BLOCK DIAGRAM



Decoding system: 10 channel resonant reed decoder followed by solid state pulse integrators and trigger circuitry to convert reed pulses into D.C. levels suitable for internal functions.

Audio stimulus tones (arbitrarily chosen):

tone A = 750 c.p.s. (low distortion sine wave)

tone B = 2,000 c.p.s.

tone C = 3,200 c.p.s.

Audio output: maximum 1 watt with master volume control and individual tone volume controls.

Power supply: internal rechargeable or conventional dry battery (Le'clanche).

Transmitter.

Frequency: crystal controlled, 27.095 Mc/s

Output power: 100 milliwatts.

Modulation: amplitude modulated C.W. (continuous wave) carrier. Modulation frequency 1600 c.p.s.

Keying: carrier of modulation off. Response turns on carrier and modulation for the duration of the response.

Response feedback: transmitter modulation is fed to audio system in harness to indicate satisfactory actuation of response mechanism.

Remote relay: the remote relay allows the base station to disconnect the response feedback loop as was called for in an earlier training procedure. This segment of the equipment is no longer used due to a change in training methods.

Packaging.

Plug-in modular techniques are used for all elements of the animal mounted system. The modules and wiring harness are contained in a canvas saddlebag mounted on the leather dog harness. Any element may be quickly removed for repairs or replacement. Overall weight of harness and equipment is approximately two pounds.

Weatherproofing.

The animal mounted system is capable of operating in rain or snow. Dirt and mud do not affect performance. The unit can withstand total immersion in water for short periods of time. The system will function when wet so long as the antenna system is not underwater.

Operational range.

Nominal 300 yards maximum 500 yards.

Physiological Telemetry Studies

I. INTRODUCTION

An investigation was made of the feasibility of equipping a dog with physiological detection apparatus (in this case to detect heartbeat: cardiotachometer), and transmitting the signal to a base station. Such information enables the operator quickly and accurately to determine whether his animal is alive and within the range of the transmitter-receiver system.

Several key factors serve as contraints in the design of a practical system:

The dog-carried apparatus must:

a. be lightweight

b. be small

c. be suitable for field use

d. have low power requirements

e. be an integral part of other apparatus on the dog both physically and electrically.

The receiving station can be one of three types:

a. A self-contained, hand held (or pack-mounted) portable receiving station which gives the operator minimal information, i.e., heartbeat is or is not being detected. The readout for this system would consist of either a tone or a light which is energized when a heartbeat is no longer detected.

b. A semi-portable receiving station which is placed in a jeep or other vehicle generating its own power and capable of carrying moderately heavy equipment. The quantitative and qualitative information displayed in this system is greater than that in a. Readout would be provided either by a portable oscilloscope, on which the heartbeat could be observed, or a speaker system with which the heartbeat signal could be audibly monitored.

c. A stationary receiving unit allows an even better evaluation of detected information. Readout is essentially the same as in b. It should be noted, however, that this is essentially a laboratory setup and is not suitable for field use.

A block diagram of the physiological telemetry system is shown in Figure 2.

The two electrodes are placed on the dog's chest. The weak signal which is detected must be amplified before being transmitted. At the receiving station the signal is further amplified and presented to the operator in either audio or visual form.

II. METHODS

Electrodes and Leads.

Two commercial electrodes were employed. They are 1/2 inch in diameter and slightly concave. When the concave surface is placed against the bare skin in the manner described below, a relatively noise-free signal (heart muscle potential) is obtained.

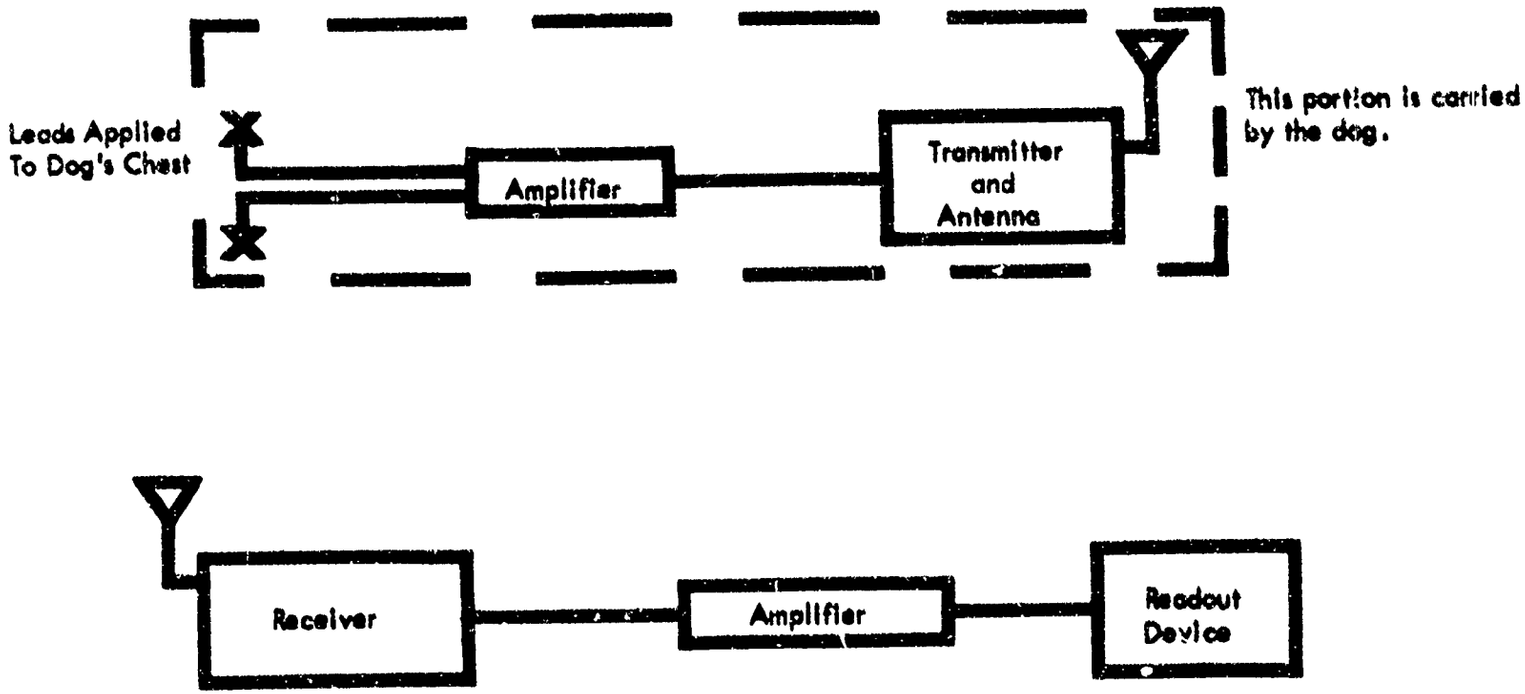
It should be mentioned at this point that the conventional procedure for detecting heartbeat waveforms involves the use of electrode paste to improve contact with the skin surface. In our experience with this transmitter, only a slight improvement in signal-to-noise ratio was obtained with the use of electrode paste when the electrodes were placed according to the technique described in the subsequent paragraphs. This improvement in signal-to-noise ratio occurs as a reduction in artifact pickup rather than as an increase in signal strength. Without the use of electrode paste the only preliminary operation necessary is shaving and cleaning of the skin.

The electrodes can be attached to a snuggly fitting leather harness. The electrodes project 1/2 in. above the inside surface of the harness, thus insuring smooth, firm contact with the skin.

Satisfactory results were obtained with the electrodes placed on the right side, two inches apart (center to center), with the most ventral electrode positioned approximately 2 inches from the sternum. Anterior-posterior axial position is at the 4th or 5th intercostal space in the lower 1/3 of the thorax.

Fig. 2

BLOCK DIAGRAM OF PHYSIOLOGICAL TELEMETRY SYSTEM



Leads are crimped to the electrodes and follow the shortest path to the transmitter. They are kept as close together as possible to minimize extraneous noise pickup. This is most effectively accomplished by twisting the two leads together.

Braided and tinned copper shielding serves adequately as lead wire since it resists breaking when flexed. Soldered joints at the electrodes should be avoided as they cannot take the stresses to which they will necessarily be subjected. Solid wire should be explicitly avoided.

Amplifier - Transmitter.

The amplifier transmitter package is manufactured by Epsco, Inc., as Bicom System Model 124A Amplifier Transmitter. This unit is primarily intended for use with confined subjects. The use of an internal antenna and very low transmission power allows excellent reception up to 50 feet, but the system becomes unreliable at distances greater than 200 feet. The system was chosen for the present investigation because it is commercially available. Systems have been designed for free range biotelemetry. Such systems, however, are available only as laboratory models, and, to date, are not stock commercial items.

The Epsco unit has the following features:

a. Small size - (2.6" x 2.3" x 1")

b. Lightweight - (5 oz.)

c. The use of F.M. transmission to minimize external noise interference.

d. The transmitter is tuneable through the commercial F.M. broadcast band (88-108 Mc). This enables the transmission frequency to be located away from any particular commercial F.M. station and still be tuned in by a commercial F.M. receiver.

e. The transmitter unit is sensitive to change in distance from the animal's body. Any change in this distance causes a slight corresponding shift in transmission frequency which is observable on an oscilloscope as vertical displacement about a horizontal center line. When the dog pants, his pack, and hence, the transmitter, follows the chest excursions. In the present experiments, an observer was able to distinguish between stationary panting and running artifact. Running produces an irregular frequency shift, while panting tends to be observed as a periodic, almost sinusoidal, vertical displacement about a center

frequency. The overall effect is to emphasize the existing respiration information. Let it be noted, however, that the ability to detect small changes in frequency is due to the fact that the transmitter delivers a very weak signal (about 10 milliwatts). If the transmitter power were increased much beyond its present level, the receiver would not be able to detect small transmission frequency changes, and the net effect would be a slight reduction in available respiratory information. Recordings that were obtained indicate that there is little or no difference between the respiratory information available through a direct connection between the electrodes and the recorder, and an indirect connection (via the transmitter). In the latter case, the transmitter and receiver were in close proximity to each other. If the dog were sent into the field (transmitter-receiver distance increased) with the transmitter attached loosely to his pack, the respiratory information available would be slightly greater than if the transmitter were rigidly attached.

Antenna - Receiver.

The antenna system consists of a single, folded dipole, curved on each end to reduce directional effects. It is the type normally employed for F.M. broadcast and television reception. Due to the low power of the transmitter, the receiver antenna is placed 50 feet above the ground.

The receiver is part of the Biocom system. It is a modified standard F.M. tuner. The difference between the Biocom unit and any standard tuner lies in the fact that the modified receiver output allows the operator to monitor the D.C. output of the discriminator, hence, the low frequency signals often encountered in biological signals may be monitored without attenuation.

Readout.

In the present study, the output of the receiver was fed into a Tektronix Dual-Beam Model 502 oscilloscope. In addition, the animal was monitored with a physiograph to obtain permanent recordings.

III. DISCUSSION

Preliminary investigations indicate that a practical telemetry system suitable to present needs can be developed. The following statements offer a generalized approach to the problem of future development of an effective system.

a. A transmitter similar to the Epsco model can be used, but it should have:

1) higher power output, and/or

2) an external antenna.

The transmitter must have enough power to allow the receiver to function with optimal efficiency at the maximum range desired. This modification would greatly improve the quantity and quality of heartbeat information obtained within the range of the telemetry system.

b. The F.M. mode of transmission and reception is satisfactory and preferable to A.M.. Receivers of adequate sensitivity are available in miniaturized form for use in a hand-held monitoring system. The use of more transmission power and a sensitive receiver alleviates the need for a large antenna mounted high above the ground.

c. Most of the work involved in developing a compact receiver unit will be concerned with the readout portion of the device. As a broad approach to the problem, it is suggested that a transistorized chopper amplifier be used at the receiver output. The reception of heart muscle potentials could trigger a circuit which would in turn prevent a readout indication from being energized. A chopper amplifier provides all of the low frequency response necessary for adequate performance. A tone or light would indicate to the operator of a hand-held receiving device that the dog is either out of range or that his heart is no longer functioning. Supplementary indicator(s) might be used to indicate malfunction of equipment.

In the semi-portable system (vehicle mounted), a field oscilloscope or speaker might be used as a monitoring device, thus increasing the amount of usable information.

Scurces of Supply

EQUIPMENT:

Knight Radio Broadcaster/amplifiers #83-4-706

Allied Electronics
100 N. Western Avenue
Chicago, Illinois

Small and large custom-made dog harnesses and saddle bags

The Horse Fair
Olney, Maryland

TMs-10 All Transistor 10 channel radio control transmitter
ZR-10 channel relayless all transistor receiver-companion to TMs-10

Citizenship Radio Corporation
810 East 64th Street
Indianapolis 20, Indiana

Universal feeder - deep cup

Ralph Gerbrands
Arlington 74, Massachusetts

Miniature 2-watt encapsulated audio amplifiers #7255 2 BT

Electronic Wholesalers, Inc.
2345 Sherman Avenue, N.W.
Washington, D. C.

Model SPX transistorized Xmitter with 1 set receiving crystals and one set transmitting crystals

Citizenship Radio Corporation
810 East 64th Street
Indianapolis, Indiana

Animal mounted auditory stimulus system

Gulton Medical Instruments
Willow Grove, Pennsylvania

Heart sound microphone with adjustable strap and cable #92-200-70

E and M Instrument Company
6030 England Street
Houston, Texas

Dog collars and harness straps

The Horse Fair
Olney, Maryland

DOGS:

German Shepherds
Beagles

Lone Trail Kennels
P.O. Box 46
Freidensburg, Pennsylvania

Labrador Retrievers

El Mona Kennels
c/o Carl E. Carlock
1435 West 11th Avenue
Gary, Indiana

Coon Hounds

Mr. Frank Wells
Chase, Maryland

APPENDIX B

TRAINING MANUAL FOR

FREE-RANGING CANINE PERSONNEL RECONNAISSANCE

CONTENTS

CHAPTER 1

GENERAL

1. PURPOSE AND SCOPE

This manual is a guide for training dogs in free-ranging personnel reconnaissance. Its purpose is to expand the utility of the scout dog to situations where the dog is off his leash and out of the handler's sight. The training assumes that the direction of movement of the military to be protected is indicated by some trail, path or road. Under these circumstances, the dog is to proceed 200-300 yards in advance of the unit and handler and is to indicate contact with the sight, scent or sound (usually scent) of a human by promptly sitting. This halt in the dog's movement will be indicated to the handler by radio.

2. ACQUISITION AND CARE OF DOGS

a. Department of the Army field manual FM 20-20 should be used as a guide for the selection and screening of dogs for scouting purposes (par. 102). One of the most qualifying traits necessary for success is a high intelligence.

b. FM 20-20 should also be used as a guide in handling, feeding and general care of the dogs.

CHAPTER 2

TRAINING AND PREPARATIONS

Section I. EQUIPMENT

3. Standard Equipment

Standard scouting equipment needed for use in the program consists of:

(1) Shoulder harness.

(2) Short training and discipline leash.

(3) Choke collar.

(4) A 25 foot leash.

(5) A leather collar.

4. SPECIALIZED EQUIPMENT

Specialized equipment used in the training is as follows:

(1) A standard leather collar with a special transmitter built in and a 1 1/2 foot antenna attached. This part of the equipment is described in detail in Appendix C of this report and will hereafter be referred to as the special collar. When worn by the dog, the transmitter gravitates underneath the neck with the antenna extending above the neck. The transmitter is tuned to transmit at 50.7 cps.

(2) A pair of Army walkie-talkies are needed both to re-

ceive the signal transmitted from the special collar on the dog and for communications between the handler and the decoy.

(3) A training whistle with the frequency adjusted so audibility is beyond human perception. This insures a more private operation in commanding the dog to return to the handler.

Section II. EQUIPMENT UTILIZATION

5. UTILIZATION OF EQUIPMENT

a. A leather collar should be used to orient the dog to the transmitting collar during the early phases of training. The special collar should be used only when the dog is proficient on long scouting problems, and the handler is ready to begin his analysis of detecting alerts.

b. It is important to remember that the harness and special collar used in actual scouting, should be put on the dog only when he is ready to begin an immediate scouting problem. The handler should always remove the equipment as soon as possible after the dog returns from an alert. The harness and special collar should never be on the dog during any type of obedience training.

Section III. HANDLER-DOG RELATIONSHIPS

6. Of primary importance for producing a capable dog in this pro-

gram is development of the dog's confidence to perform the task. This attitude of confidence and respect must exist between the handler and his dog in order to create good communication during the training phases. A good relationship may be established by the following principles.

(1) Complete discipline control over the dog is the most necessary factor. Emphasis must be placed on discipline control (FM 20-20). Particular attention must be given to off-leash commands as it is in this situation that the dog is to give his most important performance. Each and every command should be followed by a consequence. If the dog is given the command "SIT" and does not do it, he should be brought to the position sharply with a terse "NO" to the behavior the dog did perform. The dog should not be pleaded with by repeating the command. The dog should be praised as a consequence of his successes. This should be routine and frequent.

(2) The break between problems during the training sessions is the best time to reward the dog with verbal praise and petting for a job well done. Always measure the "reward" with his accomplishments. Measures of reward should include the duration and general enthusiasm of the break. (See par. 10).

(3) The dog will reveal an individual characteristic of

play habit after a short time. A conscientious handler should exploit this habit as far as possible. This creates a bit of personal friendship which will eventually cause the dog to become more handler dependent. Thus, the handler gains more control over the dog which is vitally important when the dog is required to work out of sight of the handler.

(4) Praise during the training sessions should be delivered in a soft approving voice. A loud shout may distract or confuse the dog.

(5) All of the factors of praise, including duration and general excitement of the break, measured with the dog's performance, generates within the dog a realization of his success. Essentially, results of the entire training program are dependent upon the effectiveness of communication between the handler and the dog he is training.

CHAPTER 3

TRAIL INTRODUCTION - ON-LEASH

Section I. BASIC SCOUTING

7. The dog should undergo at least one month of training in scouting on-leash before he is allowed to scout off-leash. When the training area for a session is reached, it is advisable to first give to the dog about fifteen minutes of obedience training. This is beneficial as a "warm-up" period and, also, makes the dog realize the seriousness of the forthcoming scouting session. Beginning scouting procedures are described in the next three sections.

Section II. DECOY DETECTION

8. The decoy is first placed to the left or right of the path approximately 50-75 yards down a trail or path so that the path is down wind of his position. During the early part of this phase of training, a fairly straight trail or path should be selected. The harness, then the leather collar is put on the dog. He should always be commanded to "SIT" and "STAY" while the equipment is being put on. Next the 25 foot leash is attached to the harness and the dog is positioned on the command "HEEL" to face down the path in the direction of the decoy. A soft but firm command of "SEARCH" is given, and at the same time the dog is urged forward until the leash becomes taunt. The dog

should be kept at a brisk pace and never be allowed to wander off the path. The commands "NO" and "SEARCH" should accomplish this. The dog's interest should always be kept on the problem of searching. If the dog persists in putting his nose to the ground to sniff, the handler should discourage this by the command "NO" paired with a sharp snap of the leash.

9. a. Proceeding along the trail or pathway, the handler should observe the dog closely to detect the exact moment the dog has alerted on the decoy. As described in FM 20-20, the alert may be given by tensing the whole body, raising his hackles, pricking up his ears, or by other signs. A sharply observant handler will soon learn to recognize any individual peculiarity which is an indication of an alert. The command "STAY" should be given softly at this point. After the dog has held his position at least thirty seconds he should be returned to a heeling position by use of the whistle (see par. 10).

b. On some occasions the dog should be allowed to give chase to the decoy while on the leash. However, on most occasions after the response to "STAY" has been performed, a sharp tug on the leash with a firm command of "SIT" should be given without allowing any further movement from the dog. The tension on the leash should be relaxed while the decoy quietly exposes himself. The decoy should be careful not to distract the dog from his sitting position, but only expose himself enough to allow the dog and the handler to know he is there and that the dog is correct. The handler should lavishly praise

the dog while the dog is still sitting. The handler should then return his dog the length of the leash to a heeling position using the whistle to recall the dog. The decoy remains neutral and does not further influence the dog.

c. When the dog has given evidence of boredom in scouting he should be allowed to give chase to the decoy. This idea should be used with discretion as the ultimate goal in the program is to have the dog willing to sit upon contacting a decoy. Giving chase should be used only in early phases of training, and even then if used too frequently, the dog may become confused by alternately sitting and chasing.

Section III. RETURN BY WHISTLE

10. As the dog becomes proficient at sitting on-leash upon detecting the decoy, he should be introduced to returning to the handler by command of a whistle. In early phases the handler may simply keep tension on the 25 foot leash and after the dog given an alert alternately blow the whistle and give the command "COME".

Section IV. THE BREAK PERIOD

11. After each problem the handler should immediately remove the equipment and praise the dog according to the principles outlined in par. 6 of this report. The break should never be interrupted by any serious commend and should last about 10-15 minutes ending with

the command "COME".

Section V. GENERAL PROBLEM INTENSIFICATION

12. a. After the dog becomes proficient at free-range scouting on short trials, and begins sitting when he has detected the decoy without commands from the handler, particular situations in the field should be intensified.

b. Each trial should be lengthened to a distance of 200-300 yards. Pathways should remain fairly straight and easy for the dog to follow. Confusing junctions should be avoided if possible.

c. On some problems the handler may allow the leash to drag along behind the dog to orient the dog to a free-ranging status. The handler should gradually let the dog scout well in advance, but never so far that he cannot give a verbal command. At this stage, visual contact is still necessary in order to give these commands.

d. Greater emphasis should be placed on the dog responding properly when the decoy is detected by immediately sitting.

CHAPTER 4

BASIC OFF-LEASH SCOUTING

13. When the dog has successfully mastered the principle of on-leash scouting, and the handler is confident that he will sit when encountering the decoy or "ambush", the leash should be removed from the training program. The handler should have complete off-leash control of his dog before he is allowed to scout in a free-ranging status.

Section I. SELECTION OF THE TRAINING AREA

14. The beginning sessions of off-leash training are best situated on long and generally straight paths or roadways. These conditions allow the handler to increase the distance that separates him from the dog, yet at the same time affords visual contact for controlling the dog's movements. The path ideally should be flanked on either side by heavy foliage and trees which create a natural guide for the dog to follow. The more obvious the path, the less temptation the dog has to wander off the trail.

Section II. EXTENDED DISTANCE SCOUTING

15. a. As outlined earlier in this report, the dog is briefly oriented to a free-ranging status with the 25 foot leash trailing freely behind him while the handler gradually assumes a patrolling distance

of about 25-50 yards to the rear. After becoming efficient in scouting without leaving the trail, it is of little consequence to remove the leash and allow the dog to search well in advance of the handler. The long straight trail is important in the first several sessions because the dog must realize the position of the handler, and that he is scouting on his own. Realizing this new status, the dog may attempt to:

(1) Leave the trail.

(2) Wander around, sniffing the ground.

(3) Keep a pace too fast for a patrol to follow.

Any behavior of this nature must be averted by strongly reprimanding the dog with "NO" and immediately giving him a short session of obedience training. He must at all times realize his mistakes, however he should never be punished to the extent that he becomes uncooperative and unwilling to work.

b. The routine training procedures must remain consistent.

(1) The harness and special collar should be used only when the dog is scouting.

(2) The break must be included after each problem.

(3) The dog must be kept in the habit of sitting immediately upon detecting the decoy.

CHAPTER 5

ADVANCED OFF-LEASH SCOUTING

Section I. INITIAL TRAIL SITUATIONS

16. a. The conditions of the field training area should be altered somewhat as the dog makes progress in scouting effectively.

b. The long straight trail should be gradually phased out of the training program and the following situations simulating actual patrol conditions should be introduced to the dog. The training stage at which the modifications are to be employed should be at the discretion of the handler.

(1) Dense forested areas.

(2) Numerous curves which allow the dog to become independent of the handler.

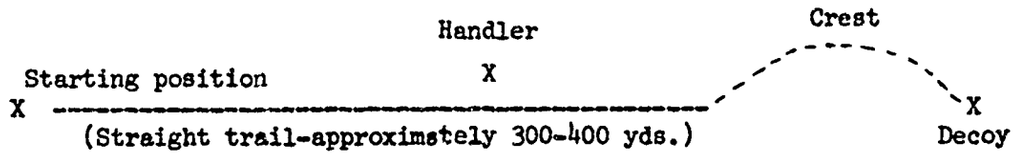
(3) Generally rugged terrain with open fields interspersed along the path or roadway. This tests the ability of the dog to remain on the path.

(4) Path junctions. If the handler is aware of a junction in the trail, he should try to keep the dog within sight so he can be commanded to pursue the correct trail.

c. To effectively make a successful transition to these obstructed trail problems, the following ideas may be introduced in

the first phase of training.

(1) The initial obstruction should be located approximately 300-400 yards down trail, with the decoy positioned upwind near the immediate vicinity of the curve, crest, etc. (see drawing). He should be placed so the dog will detect his scent only AFTER the dog passes the crest and is out of sight of the handler. After the dog has detected the presence of the decoy and sits, he is returned by whistle to the handler who should remain out of sight at the approximate position indicated.



This procedure does not allow the dog to become too far out of controlling range and at the same time the dog is conditioned to depend entirely upon his own intuition in responding to an alert.

(2) Following successful detection in this problem, the positioning of the decoy becomes more important. In the previous example, the decoy should gradually be placed farther down the trail with the handler remaining out of sight behind the crest or curve. This

affords an analysis of the reaction of the dog under increased time intervals while scouting by himself. In as many instances as possible the decoy may secretly observe the dog's scouting procedures and inform the handler of any irregularities.

Section II. PATROL INTRODUCTION

17. After the dog has mastered thoroughly the routine of searching, detection, and alerting, both in and out of sight of his handler, he must learn to work with a patrol. If the dog is unwilling to leave the group, the handler should command him to "SEARCH" from a starting position of approximately 10-15 yards in front of the patrol. In some cases the number of people in the patrol should be small (3) at first. The patrol will normally advance along at a distance of 200-300 yards behind the dog on long problems.

CHAPTER 6

DELIBERATE DIVERSIONS

18. DECOY DISTRACTIONS

The decoy should initiate into the training program various types of diversions. Such diversionary tactics should be employed only after the dog has given the alert by sitting. The dog should always remain motionless regardless of the intensity of the excitement. The dog should be strongly reprimanded with a stern "NO" if he attempts to venture into the position of the decoy.

19. Diversionary situations are an integral part of training, and the dog must be repeatedly subjected to any conditions which may distract him. Any dog that habitually becomes excited should be removed from the program.

CHAPTER 7

ALERT DETECTION

Section I. GENERAL

20. The handler should begin training in detecting the alert given by the dog only when the dog has mastered the routine of free-range scouting and responding. It is important that the handler become extremely familiar with the overall behavior of the dog as once the dog begins scouting out of sight of the handler, his activity must be interpreted by use of the transmitter.

Section II. PROCEDURES OF ANALYSIS

21. There are two procedures the handler may use in detecting trail alerts given by the dog.

(1) Visual observation.

The handler will benefit by setting up short problems which allow him to observe the dog executing an alert, and at the same time, listen to the transmitted tone. This allows the handler to know what his dog's alert "sounds like" on the transmitter.

(2) Communications with the decoy.

Once the problems extend to ambushs positioned out

of sight of the handler, the decoy should observe the dog from the time the dog is within his sight, and inform the handler by walkie-talkie of the exact moment the dog has detected his presence. Thus, the handler is able to analyze the reception of the tone at the exact moment the alert has been given.

Section III. GENERAL ACTIVITY DETECTION

22. On extended distance problems, as the handler remains 200-300 yards behind the dog, he should be able to identify the movement of the dog by a consistent rhythm of the tone. Usually the dog will establish a fixed pace when searching which the handler can easily recognize, and any variations to this pace (running, trotting, walking, a temporary stop or the actual alert) can be easily detected. If the dog has a tendency to stop often after he is out of the handler's visual range, the handler may use the duration of the steady tone as a guide to determine whether or not the alert has been given. The dog should not stop for more than a few seconds if he has not detected an ambush.

CHAPTER 8

TRAINING FOR VARIOUS FIELD SITUATIONS

Section I. RECOVERY OF THE DOG

23. a. The dog must be trained to respond to the whistle and return to the handler at any given moment, regardless of whether or not the dog has detected an ambush. However, the important function of the whistle is the recovery of the dog once the alert has been given, and "false" returns should be kept to a minimum.

b. Training procedures for immediate response to the whistle simply involve long periods of repetitious drill (see par. 10).

Section II. RESPONSIVE SITTING

24. To achieve the proper response of sitting upon detecting the ambush, the dog may be subjected to the following training procedure:

(1) The handler as a decoy.

(a) Training area.

A densely forested area with several foot paths should be used as the training area.

(b) Procedure.

The dog is commanded to "STAY" along the trail, and the handler walks away around a bend and

positions himself in the manner of an ambush 300-500 yards from the dog. He then gives the command "COME". (To eliminate confusion, the return whistle should not be used in this situation.) The handler must always keep silent after he is aware that the dog is scouting for him. As the dog approaches his position, the handler looks for the exact moment of detection at which time the handler commands the dog to "STAY". Emphasis should be placed on a sharp, immediate response. It is very important that the dog be praised highly and immediately for a good effort. This system should be repeated constantly until the dog becomes very proficient at sitting and staying immediately upon contacting the decoy either visually or by scent.

(2) Advanced training procedures.

Distances from the dog to the decoy should be lengthened until limited by audibility of the command "COME". The training area should be changed to one with more underbrush and path junctions. In addition to routine scouting, this situation allows the handler to observe the dog's behavior under more complex conditions. The dog must never be allowed to wander off the trail.

He must be kept highly attentive throughout the duration of the training session.

Section III. REMEDYING THE FALSE ALERT

25. If the dog consistently stops along the trail after he has begun to scout out of sight, the handler will be unable to detect an alert via the tone. A probable solution to ending the stopping habit is a short session of obedience training with the discipline leash. At any moment during a scouting problem, if the dog habitually stops for any reason other than the alert, the handler should firmly command the dog to "COME". When the dog returns, the handler should take off all equipment put on the choke collar and leash, and then commence the obedience training. This training should be brisk and rapid with many terse commands. The equipment should then be put on the dog again, and the problem resumed. This exercise should be used as often as necessary.

Section IV. OPERATIONAL DETECTION

26. a. In actual field operations, no one can presuppose the presence and position of an ambush, or whether or not one exists at all. The handler, considering the absence of this information, should test his ability at accurately identifying an ambush by setting up a planned route and allowing the decoy(s) to position himself anywhere along that assigned route. A third person should be designated as a patrol leader and should know the exact position of the ambush.

b. If false alerts are a constant problem in these tests, problems should be included where no ambush exists. These problems will sharpen the dog-handler efficiency and possibly show the trail conditions under which the false alerts occur.

CHAPTER 9

WIND AND SCENT

27. The wind is the most important variable condition the handler must consider in his analysis of alert detection. Several principles are important with respect to the movement of the wind. These are:

(1) The stronger the wind, the more narrow the scent cone will be.

(2) The stronger the wind, the greater is the distance at which the dog may detect the scent.

(3) The more obstructed the wind (by trees and terrain), the more likely the dog is to indicate the wrong direction to the decoy.

(4) The more the wind is coming from behind the dog, the more likely it is that he will pass the ambush area before giving an alert.

(5) In any wind over three knots the dog must be considered as searching only the side of the trail from which the wind is coming.

These principles indicate several basic procedures for the handler and the free-ranging reconnaissance dog. For example:

Principle no. 1) indicated that under conditions of a strong wind the dog should not be pushed

to a rapid pace. If he is, he is likely to run through a scent cone without giving an alert.

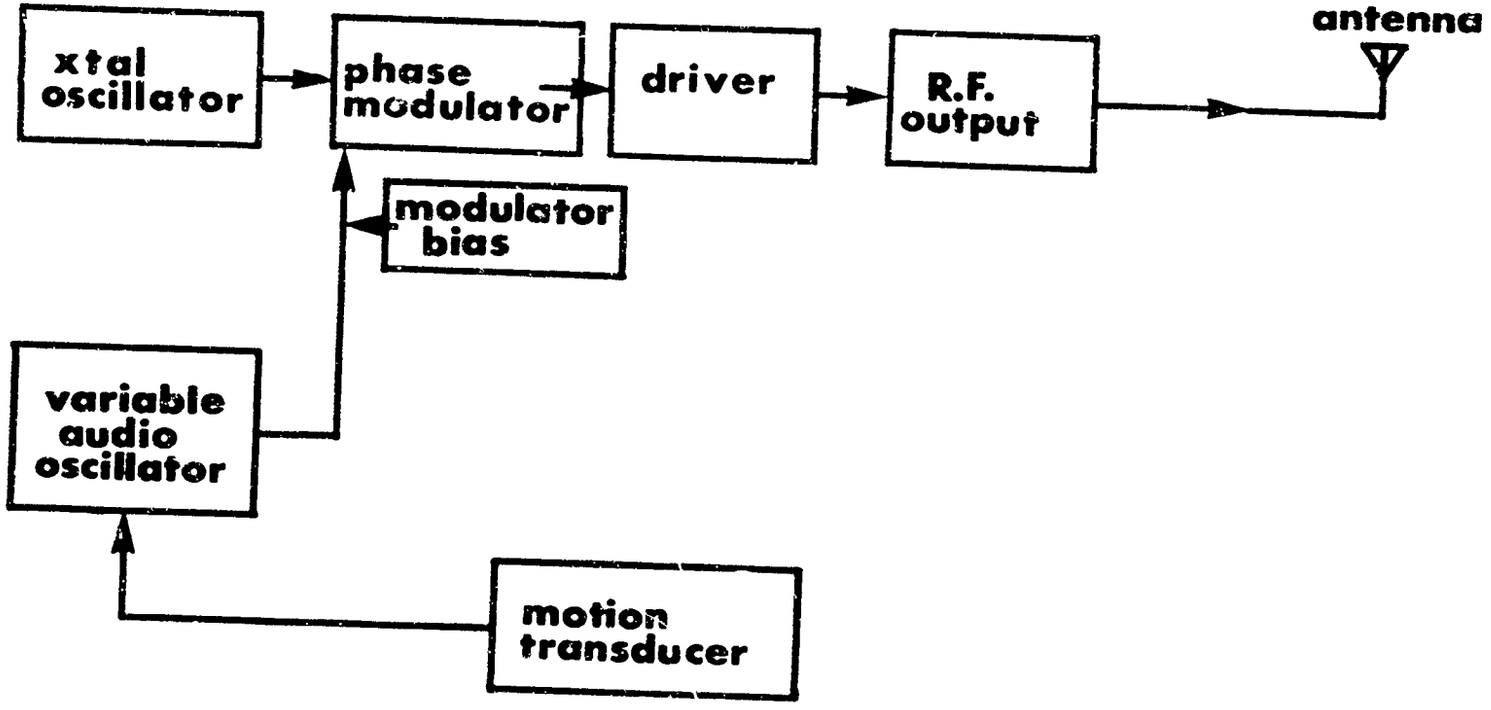
Principle no. 2) describes a condition which may be an advantage or disadvantage. If the wind is coming from behind, the dog may be useless because he will be so far up the trail by the time he reaches the scent cone and gives an alert that the patrol will be well within the line of fire of the ambush. However, if the wind is more favorable and strong, the dog will likely give his best performance, giving a long warning and a strong alert.

Principle no. 3) indicates that in heavy vegetation or rough terrain, the direction indicated by the dog during an alert should be viewed with some suspicion. He indicates the bearing from which the scent arrives and not necessarily the direction of the source of the scent.

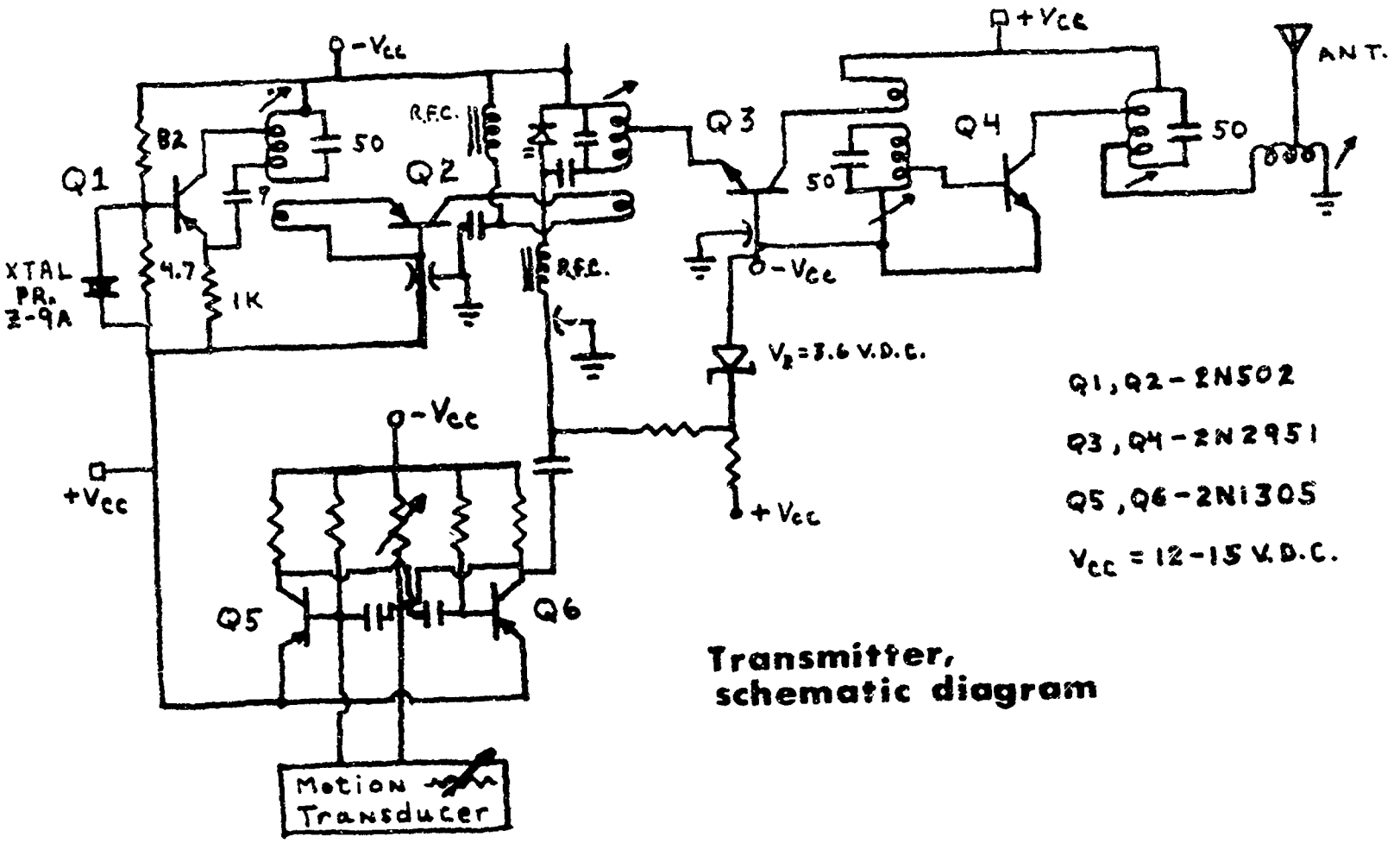
Principles no. 4 & 5) indicate caution about considering areas as investigated and clear.

APPENDIX C

TECHNICAL DESCRIPTION OF THE SPECIAL EQUIPMENT



Transmitter, block diagram



Q1, Q2 - 2N502

Q3, Q4 - 2N2951

Q5, Q6 - 2N1305

V_{cc} = 12-15 V.D.C.

Transmitter, schematic diagram